September 1977
Volume 21
Number 5

Mariners Weather Log

National Oceanic and Atmospheric Administration • Environmental Data Service

U.S. DEPARTMENT OF COMMERCE
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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
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ENVIRONMENTAL DATA SERVICE
Thomas S. Austin, Director

Cover: Winner and still champ COURAGEOUS has made her second straight defense of the America's Cup; story on page 297. Photo by Robert Munro, courtesy of Soundings.

Back Cover: The WESTWARD VENTURE enroute between Tacoma, Wash., and Anchorage, Alaska. The 24-kn trailership and its sister ship, the GREAT LAND, are participating with the National Weather Service in the collection of weather observations while underway between Tacoma and Anchorage and will contribute to the analysis of conditions between Valdez and the West Coast. See article, "Weather Service Office Valdez," on page 293. Photo courtesy Sun Shipbuilding and Dry Dock Company.

Mariners Weather Log

Editor: Elwyn E. Wilson
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PARTICIPATE IN AMVER

PLEASE PASS THIS ISSUE ALONG

The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical approved by the Director of the Office of Management and Budget through June 30, 1980.

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Mariners Weather Log

WEATHER SERVICE OFFICE VALDEZ

Albert L. Comiskey
National Weather Service, NOAA
Anchorage, Alaska

Valdez and the southern terminus of the great Alaska Pipeline are located on the shores of Port Valdez (fig. 1). Ten years ago, Valdez was a community of less than 1,000 persons. The future of the community was nebulous until the announcement that the Alaska Pipeline terminus would be nearby. Pipeline construction began in earnest in 1974, and the population of Valdez increased to nearly 10,000 persons. With completion of the pipeline, it is expected that the population will level off for a while near 6,000 persons. Valdez occupies one of the most picturesque sites in Alaska--both in summer and winter (fig. 2). The community rests on relatively flat land, but the mountains rise abruptly surrounding the city and Port Valdez. Port Valdez lies just south of the city. The terminus of the Alaska Pipeline lies about 2-1/2 mi south of Valdez along the southern shore of Port Valdez (fig. 3). During summer, the low-lying land is very green with vegetation, with the land rising rapidly to rocks and snow above 3,000 ft. The water in Port Valdez is mostly North Pacific green, except for some discoloration from glacial-fed streams. Winter in Valdez is a time of great contrasts. The lands and mountains are, for the most part, stark white from the heavy snowfall, which has averaged over 300 in in recent years. The water appears to be dark green, and on clear days the sky is a deep blue. It is probably the prettiest pipeline terminus in the world.

In anticipation of the building and completion of the Alaska Pipeline and the related increase in population and tanker traffic, the NWS established a two-man Weather Service Office (WSO) in 1973. By July, when the pipeline terminus began operation, the office was staffed by five people and provided 24-hr service. The office is collocated with the U.S. Coast Guard operations which control the Prince William Sound vessel control system (figs. 4 and 5). Both the Coast Guard and NWS offices have an excellent view of Port Valdez and Valdez Narrows. Weather teletype circuits and the NAMFAX (weather facsimile circuit) have been installed in the NWS office. In addition to normal WSO

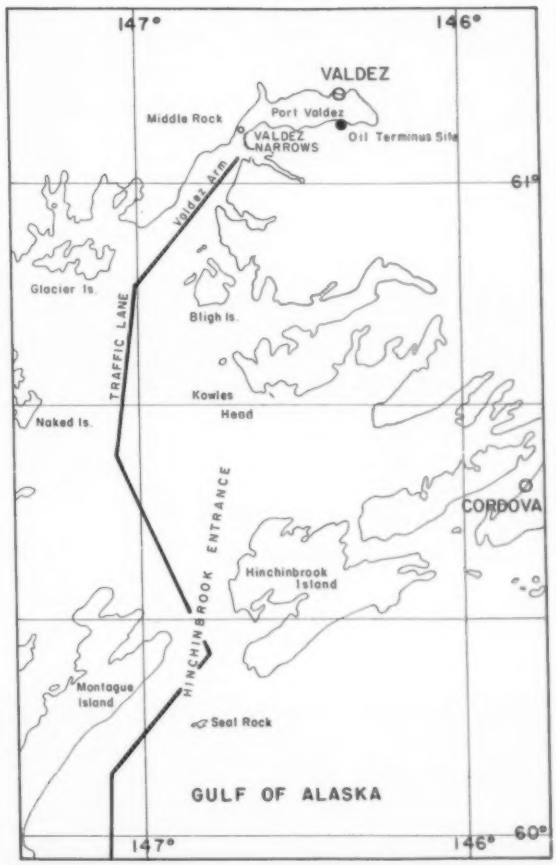


Figure 1.--Map showing Port Valdez and the traffic lane leading into it.

Figure 2.--Picturesque City of Valdez sits at the foot of rugged, snow-covered mountains on the north shore of Port Valdez. Alaska Pictorial Service.

Figure 3.--The oil terminus site is situated in a similar idealistic setting on the south shore of Port Valdez. Alaska Pictorial Service.

Figure 4.--The U.S. Coast Guard Vessel Traffic Center and Port Safety Station where the Weather Service Office is located. U.S. Coast Guard Photo.

Figure 5.--Coast Guardsmen on watch at the Vessel Traffic Center, Valdez, Alaska. U.S. Coast Guard Photo.

Figure 6.--The tanker ARCO FAIRBANKS makes a trial run through Valdez Narrows in preparation for regular tanker runs. U.S. Coast Guard Photo.

Figure 7.--An earlier test run through Valdez Narrows by a smaller tanker.

service, which includes hourly observations and special observations as required, NWS personnel prepare local public forecasts for Valdez and vicinity and Thompson Pass and marine forecasts for Port Valdez, Valdez Narrows, and Valdez Arm (figs. 6 and 7). Forecasters at Valdez receive the normal National Meteorological Center guidance via teletype and NAMFAX and special guidance from the Weather Service Forecast Office in Anchorage. The NWS Alaska Region Operational Procedures Development meteorologist develops special forecast procedures for the Valdez area.

Also included in WSO Valdez duties is the operation of continuous broadcast NOAA Weather Radio transmissions from Valdez and Cordova. Personnel also prepare brief forecasts for broadcast hourly on Coast Guard VHF radio. Through the Coast Guard VHF, NWS personnel are able to monitor traffic coming into and leaving Valdez. From this, they can obtain the latest weather conditions along the route from Cape Hichinbrook to Valdez as well as much of Prince William Sound.

WSO Valdez, because of its location with the Coast Guard and the pipeline terminus, its forecast responsibilities, and its spectacular setting, could be the most unique of all NWS offices.

Editor's Note: The first tankerload of 825,000 barrels of Alaskan oil carried by the ARCO JUNEAU departed Valdez on August 2. From the first concept it took 9 yr and $9 billion to put the first load aboard ship. It is believed that the oil pool below the Arctic tundra will produce oil beyond the year 2000.

Two tugs helped the JUNEAU into the channel of Port Valdez. A Coast Guard tug stood by. The initial load was bound for a refinery at Cherry Point, Wash.

SUMMER OF THE TWELVES

Mariners Weather Log

Dick DeAngelis
Environmental Data Service, NOAA
Washington, D.C.

It has been said that when the America's Cup leaves the New York Yacht Club, it will be replaced by the head of the losing skipper. By now you know that COURAGEOUS (fig. 8) skipper Ted Turner is still intact after sweeping to a 4-0 victory over the AUSTRALIA.

Every 3 years or so an international attempt is made to wrest the America's Cup from the New York Yacht Club, where it has remained for more than 100 yr against 23 challenges (table 1). This attempt has evolved into a summer-long trial of 12-m yachts to select one defender and one challenger to meet in sort of a world series of yachting. This series, like the Heavyweight Championship, the Triple Crown, and the World Series, stirs the interest of people everywhere. Off Newport, R.I., this was the summer of the Twelves.

In the past the trials have provided more excitement than the actual race for the Cup. In 1974 there was a tremendous battle between the twice previously successful defender and popular wood-hulled favorite

Table 1.--America's Cup Record

Year	Winning American Yacht	Challenging Yacht	Country	Number of races
1870	MAGIC	CAMBRIA	England	1
1871	COLUMBIA	LIVONIA	England	3
	SAPPHO	LIVONIA	England	2
1876	MADELEINE	COUNTESS OF DUFFERIN	Canada	2
1881	MISCHIEF	ATALANTA	Canada	2
1885	PURITAN	GENESTA	England	2
1886	MAYFLOWER	GALATEA	England	2
1887	VOLUNTEER	THISTLE	Scotland	2
1893	VIGILANT	VALKYRIE II	England	3
1895	DEFENDER	VALKYRIE III	England	3
1899	COLUMBIA	SHAMROCK	England	3
1901	COLUMBIA	SHAMROCK II	England	3
1903	RELIANCE	SHAMROCK III	England	3
1920	RESOLUTE	SHAMROCK IV	England	5
1930	ENTERPRISE	SHAMROCK V	England	4
1934	RAINBOW	ENDEAVOUR	England	6
1937	RANGER	ENDEAVOUR II	England	4
1958	COLUMBIA	SCEPTRE	England	5
1962	WEATHERLY	GRETEL	Australia	5
1964	CONSTELLATION	SOVEREIGN	England	4
1967	INTREPID	DAME PATTIE	Australia	4
1970	INTREPID	GRETEL II	Australia	5
1973	COURAGEOUS	SOUTHERN CROSS	Australia	4
1977	COURAGEOUS	AUSTRALIA	Australia	4

Figure 8.--Crewmembers of the America's Cup defender COURAGEOUS celebrate their selection to race against the AUSTRALIA in the finals. Wide World Photo.

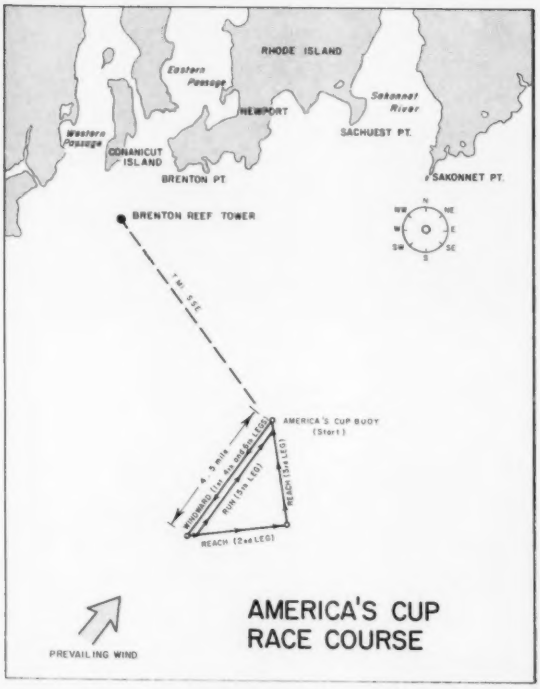


Figure 9.--This is the course layout under normal wind conditions. The course can be shifted, even during the matches, for different wind directions. The 12-m boats tack at about a 40° angle along the windward legs.

INTREPID and the sleek, aluminum newcomer--the COURAGEOUS. This year COURAGEOUS, under the skillful guidance of outspoken Atlanta Braves owner Ted Turner, became the underdog. His tough opponents were sailmaker Ted Hood, successful defender of the Cup with the COURAGEOUS in '74, and sailmaker Lowell North, a champion, almost legendary skipper in several other classes of sailboat racing. The challengers came from Australia (two), Sweden, and France.

The battle for the America's Cup is fought on Rhode Island Sound, off Newport. After the summer-long trials the New York Yacht Club selects the defender, while the challenger is decided by an elimination tournament. Like the World Series, the Cup race is the best four-out-of-seven competition. These match races are run over a 24.3-mi-long Olympic standard course, involving six legs (fig. 9). The first, fourth, and sixth legs are sailed to windward--against the wind. The second and third legs, called reaches, are sailed about 90 degrees to the wind. The fifth leg is a run with the wind, back to the America's Cup buoy for the final windward or weather leg.

Match race strategy, unlike fleet racing, is crucial before the start. At the 10-min-warning gun each crew tries to gain control by jumping on the other's tail, resulting in a circle chase. More important than getting to the starting line at the gun is to get there ahead and to the windward of your opponent. This prestart activity can be the difference in the race. In this year's trials, as in the '74 Cup race, Ted Hood sailed his vessel into the spectator fleet to shake his opponent, who had gotten on his tail. Once the race is underway the strategy is simply to do everything possible to hinder your opponent's progress. The trailing boat maneuvers for clear air, while the leading boat tries to block her. This results in a close match, where winning margins of more than 1 min are considered large.

On the windward legs this maneuvering leads to rugged and exciting tacking duels. Tacking is simply sailing your boat from one side of the wind to the other to make headway. One of the roughest tacking duels occurred in the 1964 defense trials, when the CONSTELLATION moved past the AMERICAN EAGLE in a battle that had 42 tacks on a single leg. On the downwind legs, the reaches and the run, the spinnakers (those long, nylon, parachute-like sails) are set and a jibing duel ensues. The boat behind tries to get between her opponent and the wind. Her sails would then create a wind shadow that would blanket the leader. In this duel the boat astern has the advantage of picking her own time to jibe. The leader must follow immediately to keep clear wind. The final weather leg to windward provides the fairest test in the most equal wind conditions. This often leads to a dog-eat-dog finish, where second place is a nice way of saying last. In one of this year's trials the COURAGEOUS nosed out the ENTERPRISE by .5 sec.

Weather often provides the toughest challenge. In 1967 Australia's DAME PATTIE, at her best in a breeze, was defeated as much by week-long winds and waves from hurricane Doria as by the INTREPID. During the 1974 challenger's competition Australia's SOUTHERN CROSS, suddenly engulfed by a dense fog bank, couldn't find the first turning point nor was she ever spotted by the ship at that mark. The race was finally abandoned, as it was the following day, when light winds prevented either yacht from finishing within the allotted 5-1/2 hr. Back in 1899 when Sir Thomas Lipton of Lipton Tea fame was making the first of his five challenges, the start of the series was delayed by 2 weeks by fogs and calms. This year in the semifinal challenger series, the AUSTRALIA nearly lost a race to the FRANCE I, when its crew misjudged the finish line in fog that cut visibility to 50 yd. The FRANCE I, more than 3 min behind in starting the final leg, came within 19 sec of catching the AUSTRALIA. Also in this series the Swedish SVERIGE (Sver-ee-ah) lost an important race to the other Australian yacht, GRETEL II, when she was dismasted in 30-kn winds and 8-ft seas about halfway through the race (fig. 10). SVERIGE rounded the third mark 2-1/2 min ahead when she ran into three exceptionally big waves. The first nearly swept a crewman overboard, the second knocked skipper Pelle Peterson around in the shallow cockpit, while the third snapped the 85-ft mast. The modern 12-m yachts have been so refined that they are actually designed to perform best in certain wind conditions. After analyzing 100 yr of weather records off Newport, the Australians designed their newest entry, the AUSTRALIA, to peak in light to moderate winds. The other challenger from down under, the GRETEL II, has been redesigned to perform best in light winds.

Present day rules and strategy have evolved over the 126 yr since the AMERICA first captured the Cup from Britain's Royal Yacht Squadron. This event co-

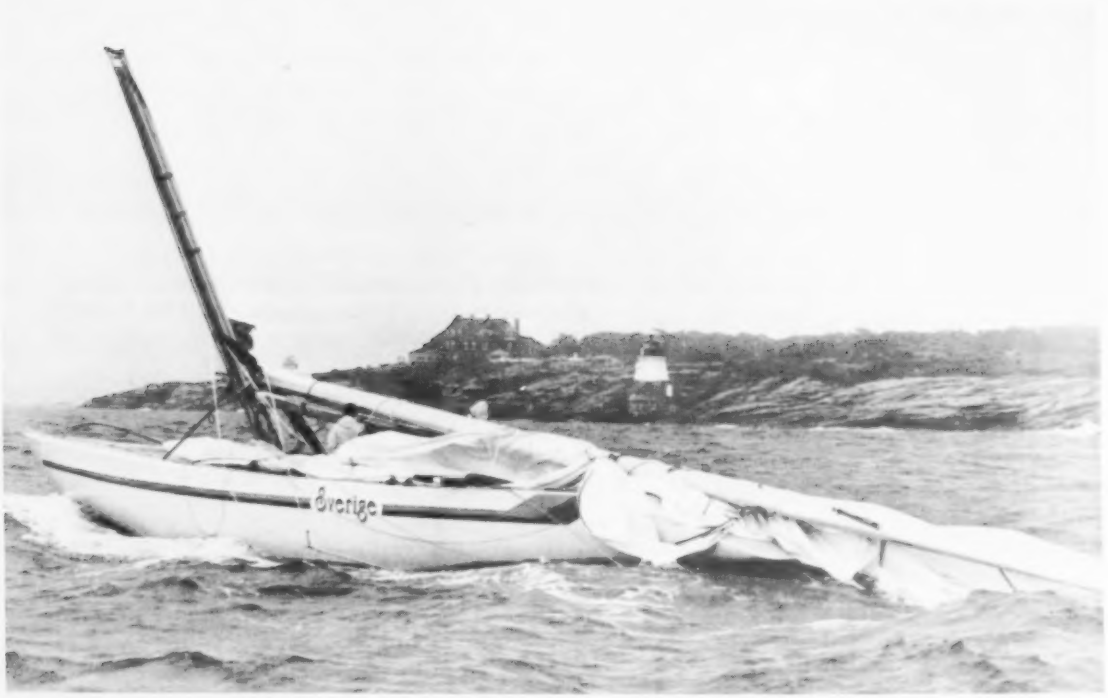


Figure 10.--Disheartened, the Swedish boat SVERIGE is towed into port after losing 60 ft of her mast in strong winds and rough seas. She had previously broken a couple of masts in trial runs in Sweden. After this accident she was down to her last one. Wide World Photo.

incided with the first World's Fair in England in 1851. John Cox Stevens, the first commodore of the New York Yacht Club, headed a syndicate that hired the well-known naval architect George Steers to build them a racing yacht that would be competitive in England, where they felt there was money to be made in racing. Steers designed the AMERICA along the lines of the small, fast American pilot schooners. After an initial victory in England, Stevens couldn't get a match. He was finally invited to participate in the Squadron's annual regatta around the Isle of Wight. The prize was a 100-guinea silver cup. The newspapers sympathetically wrote off the American challenge against 14 vessels, ranging in size from a 47-ton cutter to a 392-ton three-masted schooner, around a tough and dangerous course. Despite the fact that local knowledge of tides and currents was considered much more important than a ship's speed, the 170-ton AMERICA not only won the Cup easily, but received a congratulatory visit from Queen Victoria as well. Before returning home they also beat the TITANIA in a paltry 100-lb challenge.

After several years Commodore Stevens donated the Cup to the New York Yacht Club with the provision that they hold it as a friendly challenge for any yacht club in the world. So the America's Cup races were born.

Early challenges were anything but friendly as heated arguments took place over the rules. The first attempt by the English to regain their Cup was made by John Ashbury's schooner CAMBRIA in 1870. Pitted against 23 defenders, including the AMERICA, on a rugged 38-mi course in lower New York Harbor, the CAMBRIA did well to finish eighth. Ashbury complained long and loud about the unfair conditions. The following year his LIVONIA, which ran into a hurricane on her crossing, was the challenger. This time the New York Yacht Club agreed to a match race but retained the right to pick the defender from four vessels on the morning of each race. This allowed a decided weather advantage. Ashbury lost four straight and howled again, even threatening legal action. This was hardly the friendly competition envisioned by Stevens.

Gradually the match evolved into the more equitable race that it is today. In 1930 the course was moved to the open waters off Newport, R.I., where ship traffic is light and breezes blow steady and fresh. In 1964 the course was laid out to Olympic standards for the first time. The yachts have also come a long way. The original 30- to 300-ton schooners gave way to sloops. In the 1920's an identical design formula was introduced. This did away with time handicaps which had to be computed before the winner was declared. The large J-class sloops were replaced in the 1950's by the smaller and, at that time, less ex-

pensive 12-m yachts. The design formula takes into account such speed-producing factors as length, sail area, width (beam), and distance from the waterline to the deck. These measurements are cranked into a formula, and the result must not exceed 12 m. Today's boats are about 65 ft long with a displacement of about 27 to 37 tons.

Weather not only influences the race, but also weighs heavily in the selection of a defender. Will a boat that performs well in the steady breezes of summer hold up to the more variable winds of September? In September both light breezes and strong breezes are more common than they are during the trials. Summer afternoon winds are also steadier, blowing out of the south through west 60 percent or more of the time. September's winds are less reliable. The frequency of southerlies declines, while northeasterlies and northwesterlies become more common. Sea conditions are a difficult consideration. During the summer, sea and swells are sloppy, but usually not rough. However, during the finals the large spectator fleet of powerboats is responsible for creating choppy, turbulent conditions.

Sailing conditions in June were nearly ideal for the defenders in the preliminary trials. Winds were mainly out of the southwest at 6 to 12 kn, with 1- to 2-ft seas. Swells ranged up to 6 ft. The 22d was the roughest day as winds climbed to 15 to 20 kn. This was the day the ENTERPRISE lost her mainsail, and the race had to be called. The COURAGEOUS had an impressive 7-1 record in June, while Hood's INDEPENDENCE crew was gaining experience (2-6), and

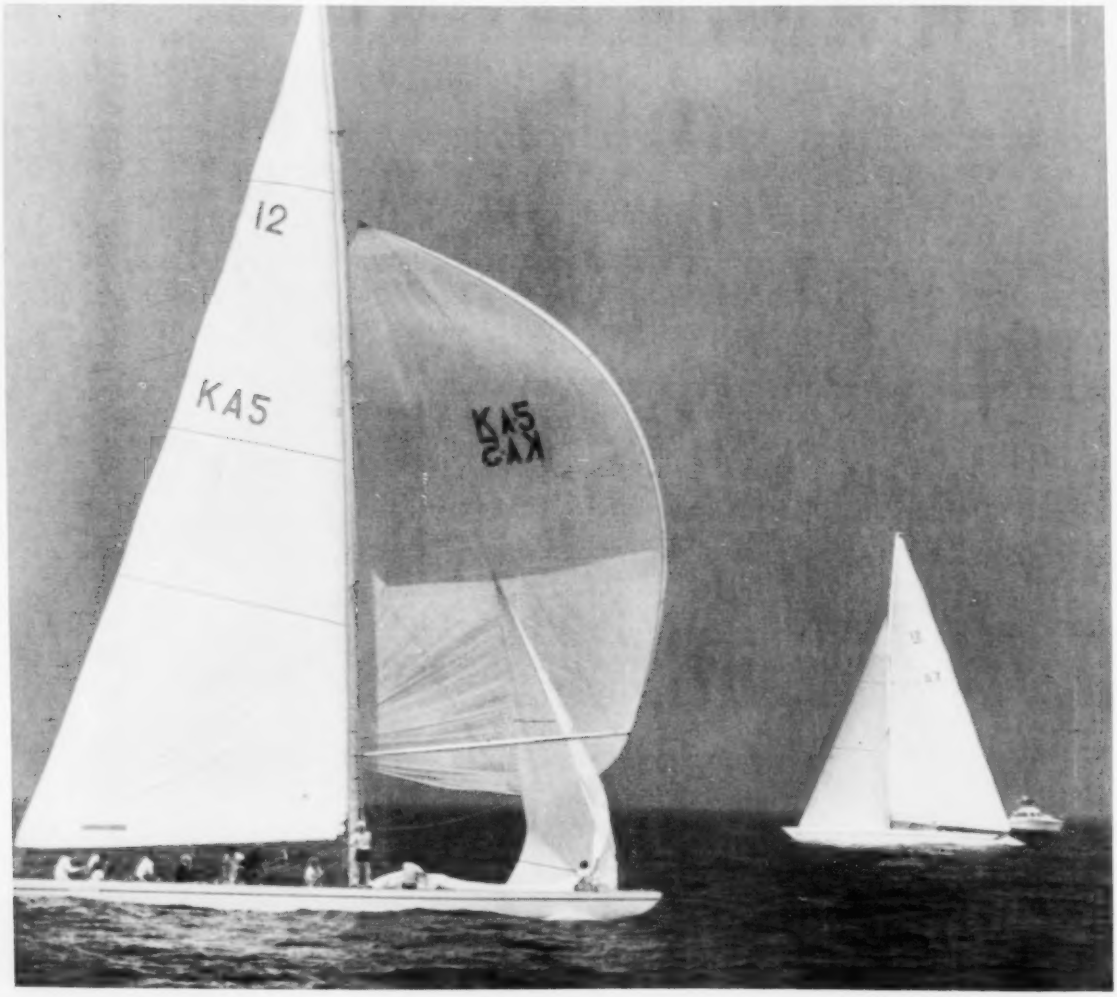


Figure 11.--The AUSTRALIA (left) leads the SVERIGE by 1 min 45 sec after rounding the first mark on her way to a fourth straight win and selection as the 1977 America's Cup challenger. Wide World Photo.

the ENTERPRISE under North (4-6) was experimenting with sails. This early series does not weigh heavily in the judges' selection. Despite the records, this was the closest series since inception of the 12-m trials in 1958. Of the 13 races sailed to a decision, 8 were decided by less than 1 min, 6 by less than 30 sec, 1 by 8 sec, and 1 by 0.5 sec.

These trials indicated that there was very little difference in hull speed between the three yachts, although the speculation was that the COURAGEOUS was weak in light winds. This was reinforced on the 23d when COURAGEOUS lost to ENTERPRISE in winds of 5 kn but then beat her in a second match as winds picked up to 12 kn.

In the July observation trials the ENTERPRISE improved to an 8-5 record, compared to 7-6 for COURAGEOUS, and 4-8 for INDEPENDENCE. The ENTERPRISE was more successful with COURAGEOUS (5-2) than she was with the INDEPENDENCE (3-3), while COURAGEOUS was 5-1 against Ted Hood's INDEPENDENCE. The encouraging news for COURAGEOUS was that she won several races in light winds. On the 24th, winds blew up to 25 kn for the first time during the races. COURAGEOUS beat INDEPENDENCE in these winds after losing to her in 10- to 15-kn winds earlier. The ENTERPRISE also looked good in moderate winds, beating the INDEPENDENCE twice on the 26th in winds of 15 to 20 kn.

During the final defender trials COURAGEOUS came out roaring. She won her first five races before suffering her only setback. One of her victories was an 8 min plus trouncing of the ENTERPRISE on August 19th. This was a crazy race, sailed in light, shifting winds that blew anywhere from the east through south at 3 to 6 kn. The lead changed hands six times, a record for the trials, but the COURAGEOUS caught a freshening breeze on the last leg and sailed right by North's floundering boat. A few days later, North was replaced as skipper by Malin Burnham, who was the upwind helmsman all summer, and Halsey Herreshoff joined the crew as tactician. The INDEPENDENCE was still having her troubles. She was put out of her misery on the 29th by the New York Yacht Club committee. That left two. The following day, after losing to the COURAGEOUS, the ENTERPRISE was visited by the committee and advised that she was through. The COURAGEOUS compiled an impressive 10-1 record in this final series and certainly earned the right to defend the Cup. It was agreed that the skill of Ted Turner was the big difference in the competition.

The AUSTRALIA (fig. 11), skippered by Noel Robbins, looked good in the seeding races, but her two losses at the hands of the GRETEL II and the SVERIGE were in winds of less than 10 kn. This led to the suspicion that she was not a good light-air boat. Baron Bich's FRANCE I was terrible. The Baron, of ballpoint pen fame, is becoming the modern Sir Thomas Lipton as he is already planning another challenge. Gordon Ingate, skipper of the GRETEL II, warned that his aging wood-hulled 1970 Cup challenger could not be beat in winds of 8 kn or less. He proved his point by thrashing AUSTRALIA by more than 4 min over a 13.5-mi course in light southwest breezes of 6 to 8 kn.

In the semifinals AUSTRALIA defeated FRANCE I in four straight races. The GRETEL II and the SVERIGE battled seven times before the Swedish boat came away the winner. Light wind conditions did not help GRETEL II in these matches; she lost three in winds of less than 10 kn.

The final trials between AUSTRALIA and SVERIGE lasted only four races. The Australians were too strong for the Swedes, who seem to forget all about match racing strategy. In one match they blew a 4-min lead, and in the final race they were trounced by more than 13 min--the worst defeat of any boat this summer.

This summer will be remembered as the outstanding one in the history of the America's Cup race. There were more boats. The races were closer. The skill of the crews was better and the boats were probably faster than any of those that came before. It was truly the summer of the Twelves.

THE MARINERS WEATHER LOG WELCOMES ARTICLES AND LETTERS FROM MARINERS RELATING TO METEOROLOGY AND OCEANOGRAPHY, INCLUDING THEIR EFFECTS ON SHIP OPERATIONS.

SHIPBOARD OBSERVATIONS OF A NORTH PACIFIC STORM

G. Brent Dalrymple
U.S. Geological Survey
Menlo Park, Calif.

Mariners Weather Log

The Geological Survey research vessel S.P. LEE departed Adak, Alaska, for Honolulu, Hawaii, at 0200 September 29, 1976, under command of Captain S.E. Keinanen with the author as Chief Scientist. The purpose of the voyage was to conduct a geophysical survey and to sample selected submarine volcanoes of the Emperor Seamount chain between 35° and 49°N and 168° and 172°E. The LEE (fig. 12) is an AGOR-3 type vessel (T-AGS 31) built in 1968 by the U.S. Navy as a coastal hydrographic ship for the Naval Oceanographic Office. She has an overall length of 208 ft 4 in and a displacement of about 1,300 tons. The LEE is now operated by the Geological Survey of the U.S. Department of Interior and has been outfitted as a geological research vessel. She carries a variety of geophysical and sampling systems and for this cruise was operating primarily a 3.5 kHz echo sounder, 3-axis gravity meter, magnetometer-gradiometer, and a 160-kJ (kilojoule) continuous subbottom profiler. For energy sources, the latter uses four sparker-source ladders trailed outboard from booms located slightly aft of amidships on both the port and starboard sides. Navigational control was by an integrated satellite system that includes LORAN-C.

Figure 12.--The Geological Survey Research Vessel S.P. LEE.

At departure a 1025-mb HIGH, which had been centered near the work area, was being pushed southeastward by a 984-mb LOW near 40°N, 150°E. This LOW had formed south of Honshu 2 days earlier and was moving northeastward at a speed of 27 kn. The LEE was on a southwesterly course (fig. 13) in light winds with a low west-to-southwest swell and a rising barometer. By 0000 on September 30, the barometer had begun to fall and the wind, which had backed to the southeast, was beginning to rise (fig. 14).

By 1200 the storm center was 230 mi west of the LEE moving northeastward at 30 kn, and the barometer had fallen to 982 mb. The winds from the east-south-

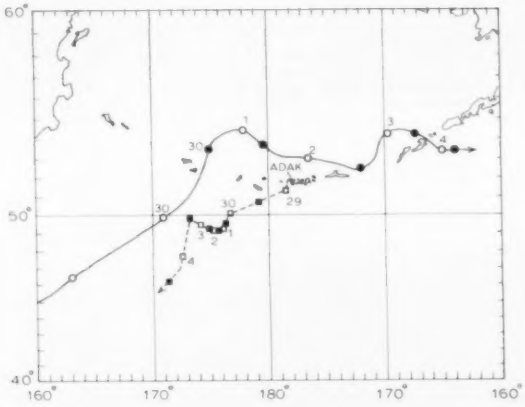


Figure 13.--Track of the LEE (squares) and storm center (circles) for September 29 to October 4, 1976. Open symbols indicate 1200 GMT positions and closed symbols 0000 GMT positions. Mercator projection. The storm track is from Environmental Data Service, 1977.

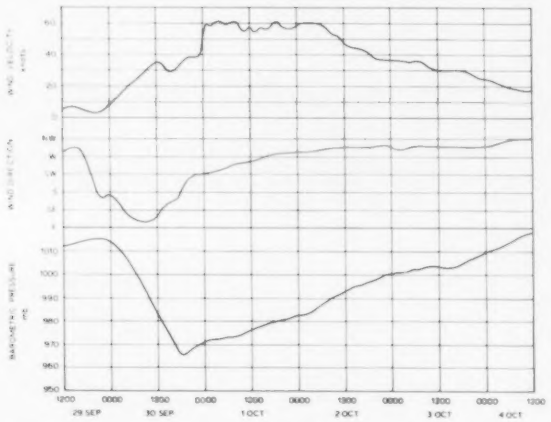


Figure 14.--Barometric pressure, wind direction, and windspeed for September 29 to October 4, 1976, as observed aboard the LEE.

east had risen to 35 kn, and it was raining. The LEE was rolling and pitching heavily in rough east-southeasterly seas and swells of 10 to 15 ft. The scientific gear was secured because the data were being severely degraded by sea noise and the motion of the vessel. The heading was changed to a more southerly course to ease the motion of the ship. Both sparker booms were raised to a 45° angle to prevent them from dipping

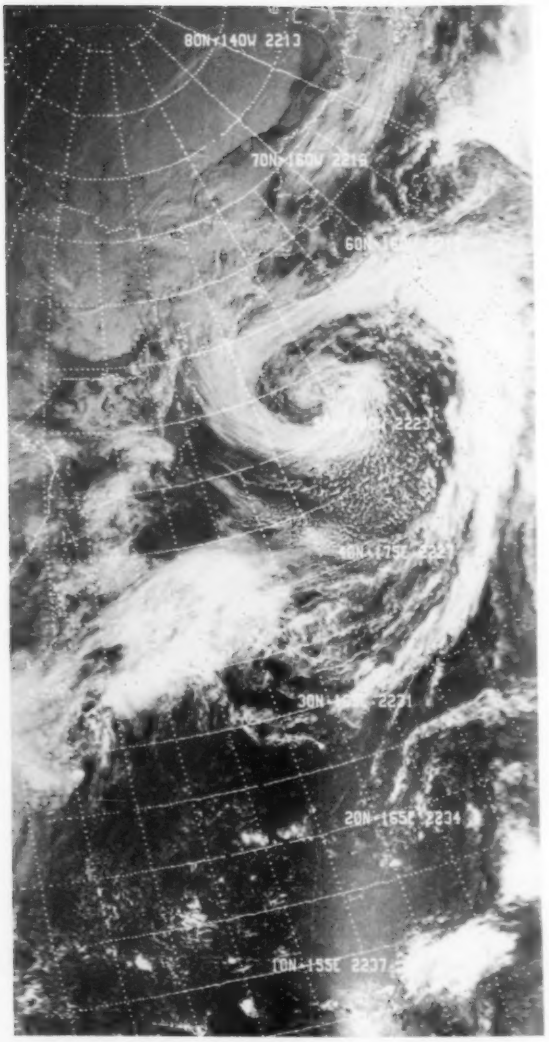
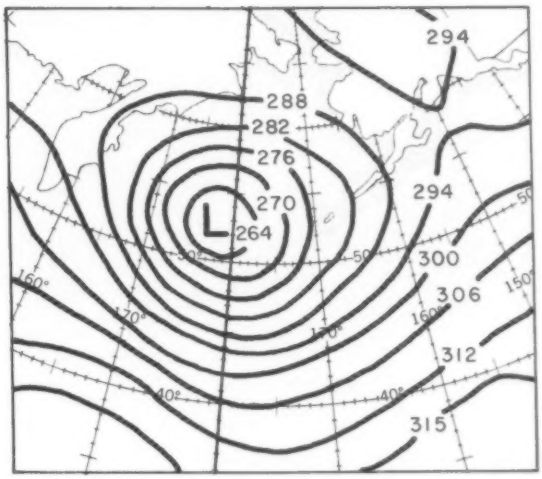


Figure 15.--The 700-mb height analysis (top) and the surface analysis for 0000 October 2, 1976. The 700-mb surface is drawn for every 60 m and the surface for every 8 mb. For a description of the history of the storm, see page 104 of the March 1977 issue of Mariners Weather Log.



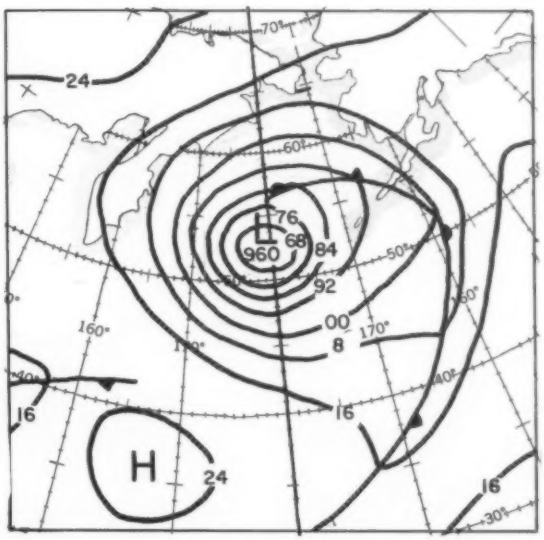
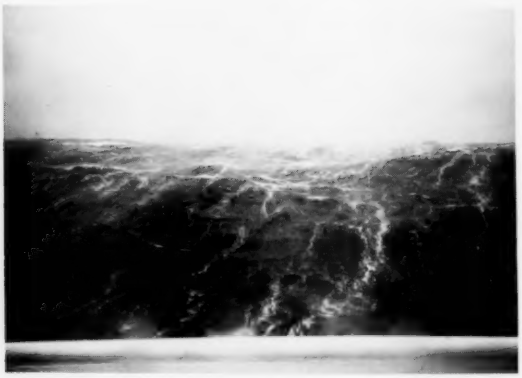


Figure 16.--The storm as it looked from 1,450 km or 780 mi above the sea.

in the seas as the vessel rolled, but the ladders, hydrophone streamers, and magnetometer sensors were left in the water because retrieval operations on the fantail were considered to be hazardous and the weather forecast indicated that conditions might not get much worse.

The barometer continued to fall at a rate of about 3 mb per hr and bottomed out at 965.5 mb at 1800 on September 30, at which time the storm center was 150 mi northwest of the LEE (fig. 13). The wind had veered to the south but was still less than 40 kn. By 0100 October 1, the wind had increased to 55 kn from the southwest and the storm, now centered 260 mi to the north of the LEE, began to slow and curve eastward. (A satellite photograph of the storm at about this time is shown as figure 65 on page 375, Mariners Weather Log 20 (6), 1976.) The LEE was now hove-to in southwesterly seas and swells to 25 ft. The seas continued to build and by 0600 were from the west-southwest reaching heights of 40 ft. The surface of the sea was white with windblown spray and foam.

During the next 27 hr (figs. 15 and 16) the LEE was battered by winds that were consistently above 55 kn with gusts to 70 kn, while the barometer continued to rise slowly at about 0.6 mb per hr. There was only occasional rain, but windblown spray was heavy. The



Figures 17 to 19.--For nearly 3 days the LEE was battered by winds that reached 55 to 60 kn and seas and swells with significant wave heights of 35 to 40 ft. These photographs were taken from the bridge at about 2000 October 1.

westerly seas and swells during this period had significant wave heights of 35 to 40 ft, and the largest waves reached an estimated height of 60 ft (figs. 17-19). Wave periods were commonly 12 sec, and periods of 14 sec between the crests of adjacent large waves were observed. From 1500 to 1900 on October 1, the bridge logged seas and swells to 50 ft. The LEE was pitching and rolling as much as 40°, yawing heavily, and taking considerable spray and occasional green water over the bow.

The winds did not start to abate until about 0900 on October 2. The barometer was then at 998 mb and still rising, but the westerly seas and swells remained heavy. By 0000 on the 3d, the wind, from the west-northwest, had decreased to between 35 and 40 kn, but the steep swells, also from the west-northwest, were still running to 35 ft. The winds and swells continued to decrease, and by 2000 the winds were 20 kn and the swells about 20 ft. Operations were begun to recover and repair the remaining overside scientific gear and to continue the interrupted scientific program. The LEE was underway with her scientific systems operating by 0400 October 4.

The LEE sustained no structural damage, but the four sparker ladders and the magnetometer-gradiometer sensors, which remained in the water during the storm, were lost and their cables sheared by the propeller. In addition, a radio antenna was lost, an XBT gun and mount on the 0-3 deck had disappeared, several stanchions were sheared off at the deck or bent, the sparker booms were bent, and a large, deck-mounted multichannel hydrophone reel (fig. 12) on the fantail sustained some structural failure from the severe rolling but was safely secured with cables and turnbuckles.

The LEE continued to collect geophysical data on the Emperor Seamount chain while pursuing a generally southerly, then southeasterly, course toward Midway, where she put in for more substantial repairs to the damaged deck-mounted scientific equipment. She arrived in Honolulu on schedule on October 20.

ACKNOWLEDGMENTS

I would like to thank the Captain and officers of the S.P. LEE for sharing their observations, H.G. Greene and E.C. Buffington for reviewing the manuscript, and all personnel aboard the LEE for maintaining their invaluable good humor during a trying, but interesting 3 days.

REFERENCES

Environmental Data Service, 1976, "Rough log, North Pacific weather, August and September 1976," Mariners Weather Log 20 (6): 370-379.

_____, 1977, "Smooth log, North Pacific weather, September and October 1976," Mariners Weather Log 21 (2): 103-111.

Nelson, S.B., 1971, "Oceanographic ships, fore and aft," Washington, D.C., U.S. Government Printing Office, 240 p.

Mariners Weather Log

SEA TEMPERATURE REPORTS FROM NORTHWEST PACIFIC COAST

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An effort to develop a simple, reliable system for measuring nearshore ocean waves by a land-based seismometer was reported in the Mariners Weather Log in 1974. Since then, the system has been installed and is operational at seven Coast Guard stations along the Pacific Northwest coast (Zopf, Creech, and Quinn, 1976). Wave observations are reported at 3-hr intervals over the Coast Guard teletype network, and a reformatted collection of station reports is forwarded to users over the local NOAA Weather Wire circuit. These reports are one input to coastal weather forecasts made by the National Weather Service (NWS) area forecast centers at Seattle, Wash., and Portland, Oreg.

ID	WX/VSB	Wind	Wave	Sea Temp.	Air Temp.	Press.	Remarks/Sta.Name
958	CY05	S05	1009	52	62	2995	Sta Yaquina Bay
			Height Feet	Period Seconds	°F	°F	

Figure 20.--Coast Guard teletype weather report format.

The teletype format for Coast Guard weather reports includes a code group for sea surface temperature (fig. 20), but it has not been used in the area because the stations had no measuring equipment. On the other hand, sea temperature information can be useful to the NWS in making forecasts of coastal fog and stratus clouds, and to the Coast Guard for estimating survival time, if the data are available consistently.

Figure 21.--Sea temperature system equipment.

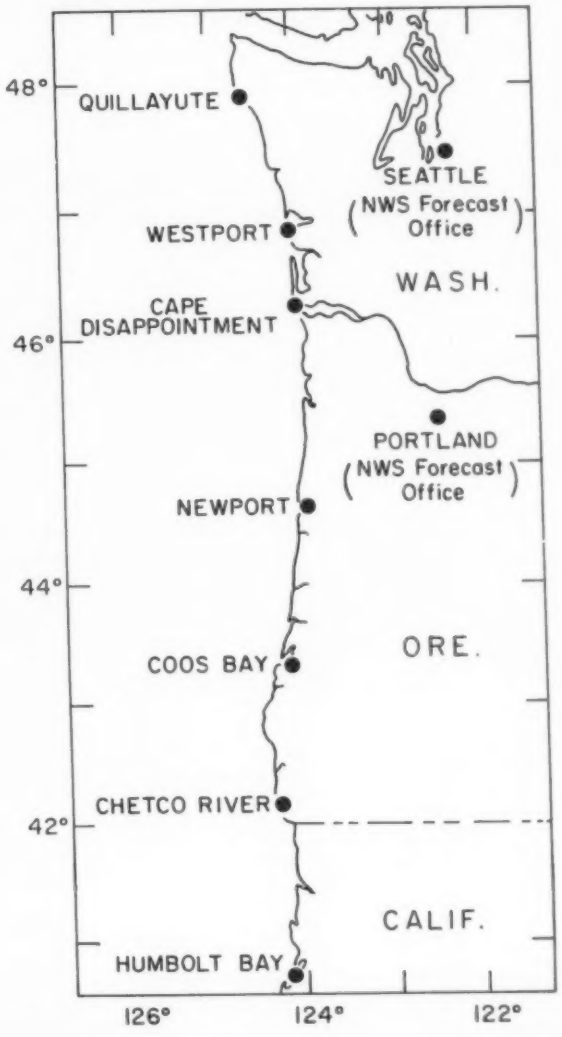

Figure 22.--Pacific Northwest Coast Guard stations with wave and sea temperature systems.

To help remedy this situation, an electronic system was developed (fig. 21) using a thermistor sensor with

Figure 23.--Wave and sea temperature readout meters, Coast Guard station, Coos Bay, Oreg.

a direct meter readout of sea temperature at the communicator's panel in the Coast Guard station. The system has a range of 30° to 70°F and costs about $400 per set, exclusive of installation labor. Tests of the initial unit were conducted at the Yaquina Bay Coast Guard Station in Newport, Oreg., during summer 1976. The sensor was mounted in a brass casing 1 ft from the bottom of the Bay (-20 ft MLLW) at the boathouse. An analog voltage is transmitted to the station over an available telephone pair. It was found that the readings obtained at this location (about 1 mi inside the jaws of the local jetties) were a useful approximation (± 2°F) to the actual nearshore sea surface temperature, especially near high slack tide, when ocean intrusion into the estuary is maximum.

Based on these results, similar installations have been made at six other Coast Guard stations (fig. 22) which also have wave measurement units (fig. 23). The seven-station network was completed in December 1976. The operating systems are reporting routinely over Coast Guard and NOAA teletype circuits to nearby NWS forecast centers. At Newport, Oreg., and Westport, Wash., the wave and sea temperature meters are also displayed on commercial cable TV channels for use by the public in planning boating operations. Public cable TV displays are planned for other locations in the future.

ACKNOWLEDGMENTS

We wish to acknowledge the cooperation of the U.S. Coast Guard (12th and 13th Districts) and the National Weather Service (Western Region) in this work, which is sponsored by the NOAA Sea Grant program under Contract 04-6-158-44094 with Oregon State University.

REFERENCES

Quinn, W.H., H.C. Creech, D.O. Zopf, 1974, "Coastal wave observations via seismometer," Mariners Weather Log 18 (6): 367-369.

Zopf, D.O., H.C. Creech, W.H. Quinn, 1976, "The wavemeter: a land-based system for measuring nearshore ocean waves," Marine Tech. Soc. J., 10 (4): 19-25.

Hints to the Observer

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National Climatic Center
Asheville, N.C.

SEA AND SWELL PERIOD AND DIRECTION

The wave observation is among the most difficult and complex in the International Ship Weather Code. It is also one of the most important elements, since wave forces on ships, structures, and the beach are among the most important engineering considerations that require actual data for planning and design.

In situ wave measurements by instruments have shown that wave-height data from nearby merchant ships are highly reliable. Direction is also reported well, but there is some bias to the compass points. The most significant problems seem to be with period. Wave period is the time interval between the passage of two successive crests of the same wave train past a fixed point.

Reporting of swell direction in tens of degrees (essentially a 36-point code) has been common practice for many years. Orders to the helmsman and entries of ship's course in the log have been expressed in degrees rather than compass points for an even longer period of time. When estimating bearings, however, the use of 8-, 16-, and 32-point systems persists and has resulted in a notable bias in the reporting of swell directions. In figure 24 the 8-point bias is evident. A 16-point bias is present to a lesser but still significant extent--note that all 16-point frequencies are higher than their adjacent frequencies.

The most common error in wave period appears to be underestimation. A recent comparison of some different wave-period data for an area near Virginia Beach is shown in figure 25. The details of this study are not important here. Of primary significance are the low values of wave period derived from ship observations (including light ships). It is suspected that the low values of period resulted from confusion of wave trains and some degree of miscoding.

Underestimating period is understandable when we consider that many wave trains are generally present at the same time. When timing the passage of a wave train, it is important that the foam, floating object, or other reference be followed from crest to crest of the same wave train. If the period is measured incorrectly from the crest of one wave train to the crest of an intervening wave from another wave train, then the result will be a period that is too short.

Since measurement is complex and coding difficult to remember, the rules and code tables from Weather Service Observing Handbook No. 1 are reproduced here for review.

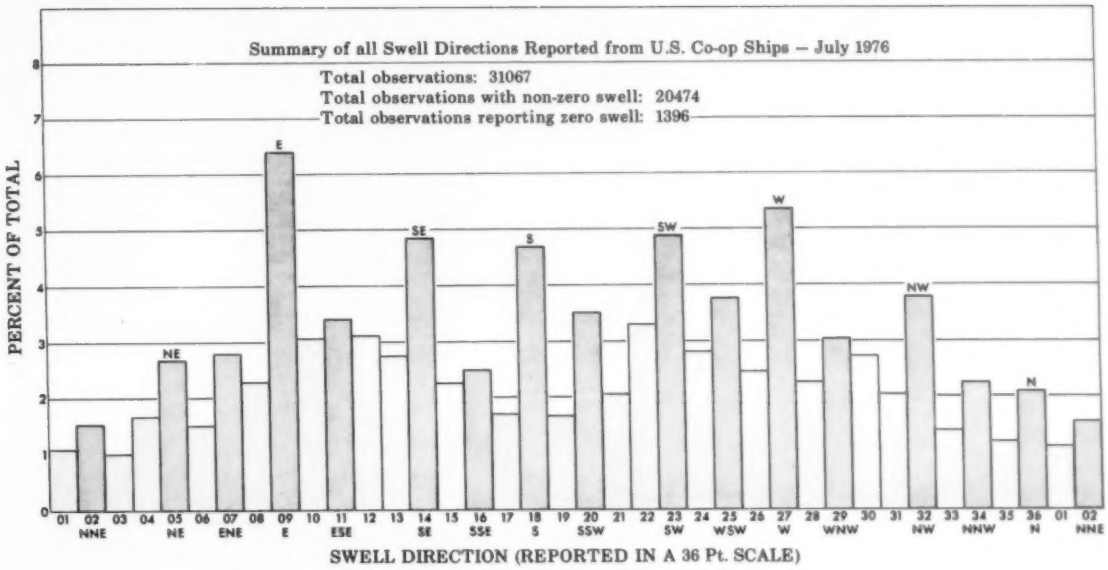
Summary of all Swell Directions Reported from U.S. Co-op Ships – July 1976
Total observations: 31067
Total observations with non-zero swell: 20474
Total observations reporting zero swell: 1396
PERCENT OF TOTAL
NE
E
SE
S
SW
W
NW
N
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 01 02
NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW N NNE
SWELL DIRECTION (REPORTED IN A 36 Pt. SCALE)

Figure 24.--A histogram of reported swell direction by tens of degrees. Note the 8- and 16-point bias.

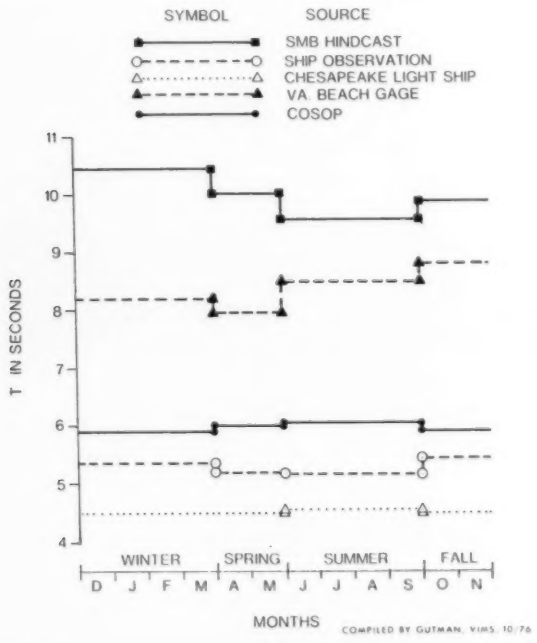

Figure 25.--Average significant wave period by season as obtained from various sources for comparison.

Wave Period. To determine the period of wind waves or swell, select a distinctive patch of foam or a small floating object at some distance from the ship. As the object falls astern select a new one. Note the elapsed time to the nearest second between the moments when the object is on the crest of the first and of the last well-formed wave in the group. Also note the number of crests that pass under the object during the interval. Continue the observation until at least 15 waves have been timed. Add the elapsed times of the various groups together and divide the total by the number of waves to obtain the average period.

Period of Wind Waves in Seconds (P_WP_W). Example: 05 = 5 seconds, 12 = 12 seconds, etc. (The code figure 00 is used when no waves are observed due to a calm sea. The code figure 99 is used when estimation of the wave period was impossible owing to a confused sea. Solidi (//) are used when the wave period is not observed for any other reason.)

Period of Swell Waves (P_W)

Code Figure	Period	Code Figure	Period
0	10 seconds	5	5 seconds or less
1	11 seconds	6	6 seconds
2	12 seconds	7	7 seconds
3	13 seconds	8	8 seconds
4	14 seconds or more	9	9 seconds
		/	Calm, or period not determined

Tips to the Radio Officer

Thomas H. Reppert
National Weather Service, NOAA
Silver Spring, Md.

FACSIMILE

On many of the surface weather charts that are transmitted to ships via radiofacsimile, some ship weather reports are included with the analysis. Do not be discouraged if the report from your vessel does not appear on the chart. The ship observations are computer plotted from selected reports received within the first 19 min of the synoptic hour (i.e., 1219Z, 1819Z, and so forth.) Because of map scale and limitations on detail density, only a small percentage of these reports can be plotted. It is very important for all who take marine observations to be assured that all ship reports are used in the preparation of warnings, forecasts, and analyses, and not just those on the facsimile chart. Ship reports are a vital part of the two-way exchange: marine observations coming in and forecasts and warnings going out.

CORRECTIONS TO WORLDWIDE MARINE WEATHER BROADCASTS, MAY 1976 EDITION

Beginning December 1, 1977, the southwestern Atlantic offshore forecast will be transmitted from the Coast Guard Communication Station NMN, Portsmouth, at 0400 GMT on frequencies 4393.4, 6521.8, and 8760.8.

The Radio Officer of the CLIFFORD MAERSK, M.P. Matthews, reports that Radio Station VWB, Bombay, India, transmits the Arabian Sea forecast on frequencies 518 and 8630 kHz. D.J. Boezaard, Radio Officer of the KAPELLE, sends word that the forecast in Spanish for the Chilean coastal area is transmitted by station CCV, Valparaiso, at 1330Z on 8558 kHz.

ACKNOWLEDGMENTS

Thanks to M.P. Matthews and D.J. Boezaard for the above information and also to W.L. Douglas, RO of the DELTA SUD, for comments regarding facsimile broadcasts.

Hurricane Alley

Dick DeAngelis
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Washington, D.C.

NORTH INDIAN OCEAN - MAY AND JUNE

This is the heart of the spring tropical cyclone season in the North Indian Ocean. One or two storms can be expected during this period. True to form, this year produced a May tropical storm in the Bay of Bengal and one of the most devastating storms on record in June in the Arabian Sea (fig. 26).

The Bay of Bengal storm, generating winds up to 50 kn, moved across the Mouths of the Ganges on the 13th (fig. 27). Central Bangladesh was the hardest hit. Three people were reported killed, and over 100 people were injured by the storm, which uprooted trees and smashed houses in Dacca and the surrounding area. The storm was first spotted on the 10th in the central part of the Bay. As it developed, it treked north-northeastward. Maximum winds reached 50 kn on the 11th and remained at that intensity until the storm moved ashore.

The Arabian Sea storm formed about 280 mi south-southwest of Bombay on June 9. In conjunction with a monsoonal flow, the storm generated a heavy south-westerly swell to the east of its center. Swells of 18 to 20 ft were reported on the 11th by the STRATHMEIGLE and by several drilling rigs which were forced to shut down. The storm was a hurricane by the time it reached the 20th parallel, where it turned to the west. The hurricane pounded the TEXACO PLYMOUTH, which lost two lifeboats and suffered struc-

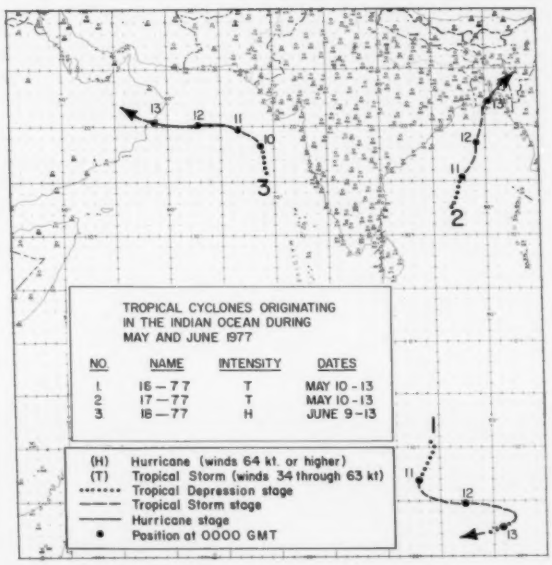
TROPICAL CYCLONES ORIGINATING IN THE INDIAN OCEAN DURING MAY AND JUNE 1977
NO. NAME INTENSITY DATES
1 16-77 T MAY 10-13
2 17-77 T MAY 10-13
3 18-77 H JUNE 9-13
(H) Hurricane (winds 64 kt. or higher)
(T) Tropical Storm (winds 34 through 63 kt)
Tropical Depression stage
Tropical Storm stage
Hurricane stage
Position at 0000 GMT

Figure 26.--Indian Ocean tropical cyclones, May and June 1977.

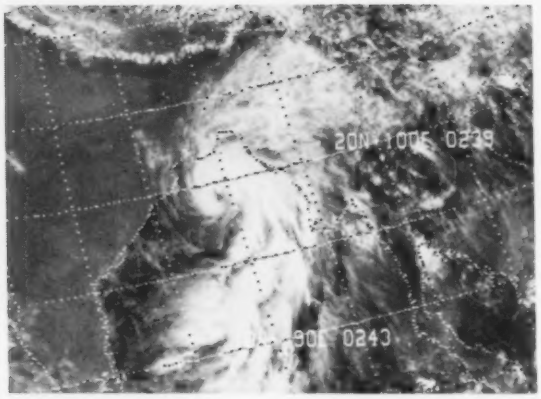

Figure 27.--Winds of 50 kn swirled around this Bay of Bengal storm as it moved toward the Ganges on the 12th.

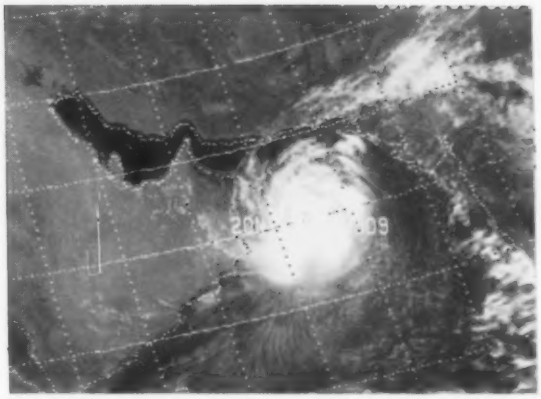

Figure 28.--Poised to strike the coast of Arabia on the 12th, the hurricane enters an otherwise cloudless region.

tural damage. She fared better than the 4,943-ton freighter BUXOM ISLAND, which sank near 20°N, 63°E. Fifteen survivors were rescued, but twenty-three men in a lifeboat were missing. The storm slowed (fig. 28), and winds reached a peak of 85 to 90 kn before it moved ashore over Masirah Island and then onto the mainland of Oman.

Virtually the entire population of Oman's Masirah Island was left homeless by the hurricane, which lasted 4 days. At least 50 people on the island were killed, and 20,000 were left homeless. The hurricane also caused severe damage to the sultanate's main agricultural crops; thousands of palm and lime trees were knocked down on both the island and the mainland.

Although tropical cyclones cross the coast of Arabia only about once every 3 yr, their torrential rains can contribute to the otherwise sparse local rainfall. At Salalah during the 25-yr period from 1943-67, about one-quarter of the total rainfall was associated with tropical cyclones, and almost all of this with just four storms. In November 1966 a severe cyclone brought about 8 in of rain, while in May of 1963 another dumped 9 in of rain on this city, which records an average annual amount of about 4.4 in. The average annual amount at Masirah is just 1.5 in.

SOUTH INDIAN OCEAN - MAY AND JUNE

The South Indian Ocean is usually quiet during this period. However, on May 10 satellite photos indicated a tropical depression forming in midocean. Climatology indicates that the few storms which form in this region have moved toward the southwest. This system started a little west of south, but then it swung toward the east as it reached tropical-storm strength. Maximum winds were estimated at about 40 kn on the 11th and 12th. However, as the storm turned toward the west on the 13th, it weakened rapidly.

On the Editor's Desk

SHALLOW WATER VLCC TRIALS COMPLETED

The completion of 9 days of shallow water maneuvering trials by a 278,000-ton very-large crude carrier (VLCC) is expected to not only improve the shipping industry's knowledge of supertanker handling characteristics, but also to improve the training of maritime personnel.

The trials, sponsored by the Maritime Administration, the Coast Guard, and the tanker committee of the American Institute of Merchant Shipping (AIMS), were carried out by the Exxon-owned VLCC ESSO OSAKA, southwest of Galveston, Tex., in waters providing as little as 11 ft under the keel of the ship, which had a draft of 71.5 ft.

An Exxon spokesman explained that the objective of the trials was to increase the understanding of VLCC handling in shallow water.

Although a vast amount of data exist from model and computer programs, the trial of the ESSO OSAKA was the first of its kind in the world. The knowledge gleaned will take some months to process and will be used to improve computer programs for ship handling simulators now being used to train ships' officers and pilots, providing a more realistic training program and promoting trainee confidence.

It will also sharpen the data on the size and configuration of port safety zones--and in the construction of new ports such as those in the U.S. Gulf--as well as in the research and design of ships.

The trials involved the study of vibrations caused by the vessel's pressure waves rebounding from the ocean floor back into the ship's hull. In deep waters, the ship has passed the spot before pressure waves can rebound; therefore, it is no problem. In shallow waters, however, it can affect the ship's "critical" speed, the danger area at which the engine revolu-

Figure 29. --The inside of the specially equipped Coast Guard C-130 aircraft showing the console of the Airborne Oil Surveillance System (AOSS). The AOSS is being shown to VAdm. Perry, Vice Commandant of the Coast Guard. U.S. Coast Guard Photo.

tions could theoretically set up a self-sustaining resonance or vibration which, if not checked by a change of speed, would eventually shake the ship to pieces.

Similarly, there were emergency stop efforts at port maneuvering speeds--normally about 3-1/2 kn--which showed that the ship stopped in the water in between two and three lengths. Model tests showed also that a ship has a greater turning circle in shallow waters. The extent of this was judged to be not as wide as had been anticipated.

AIRBORNE OIL SENSOR UNIT IN OPERATION

The U.S. Coast Guard has begun operating an experimental sophisticated airborne sensor system to detect the illegal discharge of oil in nearly all types of weather, day or night.

Installed aboard a C-130 aircraft, the Airborne Oil Surveillance System (AOSS) combines four sensors to spot pollution violators and provide evidence toward their prosecution.

The specially equipped aircraft is based at Elizabeth City, N.C., and conducts routine oil pollution surveillance patrols out to 50 mi along the east coast of the United States.

The sensors include a side-looking radar and a passive microwave imager to locate and map oil spills within a 25-mi swath along the aircraft's path. An aerial reconnaissance camera and a multichannel line scanner provide clear images of oily discharges and identify suspected violators.

A computer-controlled console aboard the aircraft integrates the sensors with a position reference system. This arrangement permits the equipment operator to view and interpret the sensor data as it is received and to make immediate enforcement decisions when a violation is detected (fig. 29).

Officials say the AOSS will be particularly effective in detecting a major source of ship-generated marine pollution; that is, indiscriminate bilge and ballast pumping and tank washing operations.

The Coast Guard warned that polluters who previously conducted their illegal activities under cover of darkness or during bad weather will find it more difficult to avoid detection.

ICEBERGS MAY BE HAULED TO MIDEAST

A project that could make deserts bloom moved a step nearer to reality with the formation of a new company to tow icebergs from the Antarctic to Saudi Arabia. The chairman of the Saudi Saline Water Conversion Corporation announced the formation of the company, Iceberg Transport International, following

a 2-day conference of irrigation experts, polar explorers, and industrialists from seven countries. The project is being undertaken by a French engineering firm, Center Dinformatique Commercial Economique et de Recherches Operationelles (Cicero).

Tentative plans call for hauling icebergs weighing 100 million tons from Antarctica across the Indian Ocean and into the Red Sea to the Arabian Peninsula, where the ice would melt into water for drinking and irrigation.

A Cicero spokesman said an iceberg would be hauled by half a dozen powerful tugboats similar to those used to tow oil-drilling platforms. Cruising speed would be 1 kn an hr, and the 8,000-km journey to Saudi Arabia would take 6 to 8 months.

The iceberg, protected against waves, water, currents, and the sun by a 457-mm-thick plastic wrapping, is expected to lose about 20 percent of its mass before arrival off the Saudi port of Jiddah. Even then, the water delivered would cost 53 cents per m^3, compared with 80 cents for desalinized sea water.

MARITIME ARCHIVES CENTER FLOURISHES ON NANTUCKET

Pirate voyages, explorations, court-martials, shipwrecks, fishing and packet voyages, along with just about everything else relating to man and the sea from all nations and historical periods are contained in the collection of documents preserved on microfilm at the International Marine Archives, Inc. The nonprofit research center on Nantucket Island in Massachusetts is believed to be the first of its kind in the world.

Since its founding 5 years ago, IMA has microfilmed more than a half million pages of marine documents, issuing yearly catalogues of additional holdings which are sent to some 200 institutions and individuals in 31 countries. IMA also has initiated microfilm programs in other parts of the United States, England, France, and the Netherlands.

Eyewitness reports of marine experiences, ranging from logs and ledgers to accounts of discoveries and explorations, are contained in 4,108 accounts, each one preserved on microfilm at IMA.

A data sheet, including the details of each document, is prepared for foreign and domestic microfilm. The information is then transcribed on file cards which are used to prepare the IMA catalogue.

The 1977 catalogue of archive holdings contains 933 manuscript items, the largest number ever acquired in 1 yr. The quality of the material is particularly noteworthy, since it contains the most extensive group of French, English, and American voyages of exploration collected so far.

Among them is the early surveying voyage of the schooner CASUARINA under Lt. Louis de Freycinet, with 101 charts of the southern Australia coastline. IMA has the voyage's rough and smooth Logs and its volume of coastline charts microfilmed in France at the French National Archives.

Also new are 20 manuscript accounts of the United States exploring expedition of 1838-41, commanded by Lt. Charles Wilkes. The manuscripts record correspondence with the Secretary of the Navy and subsequent court-martial proceedings against Wilkes.

Other additions include the William Dampier and William Cowley narratives of their pirate adventures on the west coast of South America and subsequent voyages around the world from 1683-91.

Next year IMA will expand its microfilming program to include the acquisition of Dutch East India voyages of the 1590's as well as additional material from the archives office of Tasmania. Surveys will also be made of archives in Bremen and Hamburg, Germany.

IMA is staffed by volunteers who handle administrative and clerical duties and maintain the Exhibit Room, which displays journals, old prints, and paintings.

The archives are open to researchers and anyone interested in the lore of the sea. The building is open year-round from 10 a.m. to noon and 2 to 4 p.m. daily.

IMA is administered by a president and a board of nine directors. The group, elected annually, includes people with broad backgrounds in education, law, foreign service, corporate management, and publishing. An advisory board comprised of members from Britain, France, Australia, Tahiti, and New Zealand serves as a liaison with marine historical agencies throughout the world.

FITZGERALD SINKING BLAMED ON HATCH LEAKS

The ore carrier EDMUND FITZGERALD, which sank in Lake Superior on November 10, 1975, with the loss of 29 lives, probably suffered flooding of the cargo hold because of leaky hatches, the U.S. Coast Guard announced on August 2. (Mariners Weather Log 20 (3), May 1976)

"Loss of buoyancy, due to massive flooding of the cargo hold, probably caused the sinking of the S.S. EDMUND FITZGERALD during a severe storm on eastern Lake Superior," the Coast Guard said in a summary of its inquiry board findings. The board concluded that the flooding most likely took place "through ineffective hatch closures and was concentrated forward."

The vessel dove into a wall of water and never recovered, with the breakup occurring as it plunged to or when it struck bottom. The sinking was so rapid and unexpected that no one was able to successfully abandon ship.

There was no indication that the FITZGERALD was overloaded. They could have put in more cargo and would still have been below the cargo marks.

The sinking occurred during a bad, typical November storm--the worst of the year, but not the worst in history. A number of ships out in that storm did survive.

It is believed that at about 1 a.m., with water breaking on deck, the first seepage began to occur. The 26,116 tons of iron ore in the cargo hold of the 730-ft ship absorbed some of the water and the remainder poured beneath the ore and was not noticed by the crew, causing the vessel to ride lower in the water. About 3:30 p.m., the boat began to list.

When asked if the ship should have been abandoned then, a member of the inquiry board replied, "No. If the master was able to recognize what was occurring, he could have been able to pump it out and ideally find a lee shore (sheltered from the wind) to duck into."

The bow and stern of the FITZGERALD have been located, but no bodies were ever recovered.

Figure 30.--A copy of the photograph of the sea monster taken by a crewmember of the Japanese trawler ZUIYO MARU. The partially decomposed body pulled from the sea off New Zealand had two fins, front and rear; a 5-ft neck; and a 6-ft tail. Wide World Photo.

SALT-WATER NESSIE OR PLESIOSAURUS

Was it a deep-sea version of the Loch Ness monster, a prehistoric plesiosaurus, or a hoax?

Excited natural history experts believe that the mysterious 2-ton carcass caught off New Zealand may have been a plesiosaurus--a huge reptile thought to have died out 100 million years ago. No one can say for sure, though, because whatever it was it smelled so bad that the Japanese fishermen dumped what one paleontologist described as "possibly the find of the century" back into the sea.

The 2,460-ton ZUIYO MARU was trawling off Christchurch, New Zealand, on April 10, 1977, when its nets snared the unidentified dead animal at 1,000 ft. Hoisted to the surface, the creature was about 32 ft long with four flippers and a long neck and tail (fig. 30).

The overpowering odor and the unpleasant fatty liquids oozing onto the deck overcame the fishermen's curiosity over an animal neither they nor any of the natural scientists since consulted had ever seen before. Afraid that the animal would spoil their cargo of fish, they took measurements and photographs and dropped the carcass back into the ocean.

Japanese paleontologists are aghast that the skeleton was not preserved for study. On the basis of color photographs and sketches made by a fishery company executive who was on the trawler, they believe it may have been a plesiosaurus. The marine reptiles flourished 100 million years ago, and one species of plesiosaur is known to have lived in the seas off eastern Australia.

The director general of animal research at the Japanese National Science Museum said, "It's not a fish, whale or any other mammal, it's a reptile and the sketch looks very like a plesiosaurus."

When the ship returned to Japan, the photos, sketch, and notes were turned over to the National Science Museum. According to the director, "This was a precious and important discovery for human beings.

It seems to show that these animals are not extinct after all. It's impossible for only one to have survived. There must be a group."

If verified, the existence of living plesiosaurs would be an astounding discovery. The available evidence does not allow a definite conclusion, yet natural historians certainly do not dismiss the possibility that descendants of the prehistoric giants may be lurking in the great depths of the southern seas. The marine environment is generally more favorable than land for the survival of dying species, and if plesiosaurs exist anywhere, the southern seas are a good bet. Fishing crews have been alerted to find another.

It was learned later that some fibrous tissue from the creature's fin was saved. The amber-colored fiber was 23.8 cm long and a maximum of 2 mm in diameter. It branches into three threads at one end. The fin was covered with gelatinous fibers. This horny fiber is the only physical proof of the monster.

The crew of another Japanese fishing boat, the No. 25 MITO MARU, reported seeing a similar creature in the same waters during April 1974. They said it was apparently chasing fish at the time. All 17 crewmen were working on deck and observed whatever it was for about 10 min. The creature appeared to be about 15 m long with a head that resembled a cobra.

It was also reported that these creatures could have been basking sharks which closely resemble the plesiosaurus.

MORE ON 1976-77 SEVERE WINTER

The winter of 1976-77 was not the ordinary, run-of-the-mill winter. It was warm where it should have been cold, and it was cold where it should have been warm.

Consider these facts reported by A. James Wagner of NOAA's National Weather Service:

--In the Ohio Valley temperatures averaged as much as 19°F (11°C) below normal in January; it was generally the coldest month on record for that area.

--In Anchorage, Alaska, temperatures averaged 20.2°F (11.2°C) above normal in January; it was the warmest month on record.

--Buffalo, N.Y., had 53 consecutive days of snow ending February 10. There was a record 38 in on the ground the last 3 days of January.

--In the Pacific Northwest, January was one of the driest on record.

The litany continues. For Detroit, Mich., it was the first January on record in which the temperature never went above freezing. It was the coldest month on record for cities in Missouri, Iowa, Ohio, Illinois, Indiana, Pennsylvania, New Hampshire, Kentucky, Tennessee, Georgia, and Florida; for Fairbanks, Alaska, the warmest January in 40 yr.

Wagner reported at a recent meeting of the American Geophysical Union in Washington, D.C., that the unusual weather was caused by two errant high-pressure areas which found their way well up into the Northern Hemisphere.

Usually, these upper air high-pressure areas are found in the subtropics. As long ago as last summer, however, they made their way up to middle latitudes where they helped cause the hot, dry weather over the north-central United States and western Europe during the summer. One of them, together with a strong low-pressure area over the Pacific, remained more or less in position over British Columbia through the fall and into the winter, creating a strong, recurring pattern of upper air wind currents. These pushed unusually cold air southeastward across the eastern United States for several months.

Also, the combination of the upper air wind pattern and the northwestward movement of the other high-pressure area from the Atlantic to the Arctic region caused a cold, low-pressure area normally found over northern Canada to be displaced southward over southeastern Canada and the northeastern United States. This brought frigid Arctic air to that section of the country, while mild air from the Atlantic moved northwestward into Canada. The abnormal weather experienced during January was the result.

The following cities in the United States had all-time record low temperatures in January 1977. The date of the record low illustrates the extent of the unusual weather.

City	Temp. (°F)	Day
Huntsville, Ala.	- 1	17
Fort Smith, Ark.	-10	11
Miami, Fla.	31	20
Pensacola, Fla.	10	19
West Palm Beach, Fla.	27	20
Chicago, Ill.	-19	16
Peoria, Ill.	-25	17
Lake Charles, La.	18	10
Sault Ste.Marie, Mich.	-30	9
Saint Cloud, Minn.	-43	9
Jackson, Miss.	6	19
Columbia, Mo.	-18	17
St. Louis, Mo.	-14	16
Atlantic City, N.J.	-10	17
Cincinatti, Ohio	-25	18
Columbus, Ohio	-19	17
Dayton, Ohio	-21	17
Pittsburg, Pa.	-14	17
Williamsport, Pa.	-17	18
Houston, Tex.	18	19
Lynchburg, Va.	- 8	17
Norfolk, Va.	5	17
Beckley, W.Va.	-18	17

A few examples of the contrast between January minimums and sample July 1977 temperatures are as follows: Peoria, Ill., -25° and +100° for a 125-degree spread; Akron, Ohio, -18° and +100° for a 118-degree spread. There are many others, maybe with even higher spreads, as many high-temperature records are being broken this summer.

For further information on the winter of 1976-77, see the March and May 1977 issues of the Log.

JAPAN WEATHER SATELLITE LAUNCHED

Japan's first weather satellite was launched from Cape Canaveral, Fla., on July 14. The geostationary meteorological satellite (GMS) was named Himawari or Sunflower. The GMS, stationed at longitude 140°E,

22,300 mi (35,800 km) above the Equator, will transmit detailed weather images every 30 min both day and night. The images will enable Japanese meteorologists to more readily identify, track, and monitor severe storms of all types, including typhoons over the western Pacific, eastern Asia, and the Indian Ocean. More than half of the tropical storms in the world develop in this area. Many lives are lost and families left homeless by severe storms in Japan each year. The Himawari will aid in more accurate and timely warnings.

Himawari will join the stationary weather satellites already launched by the United States. It will be part of the International Global Atmospheric Research Program (GARP), which is designed to improve long-range weather forecasting.

HARBOR CHANNELS CAN CAUSE SHIP HANDLING PROBLEMS

Two scientists in the ocean engineering program at Texas A&M University claim that critical information needed to design harbor channels for deep-draft vessels (those drawing more than 35 ft) is not available either in textbooks or through formal education.

A phenomenon known as "squat" can under certain conditions cause a large vessel drawing 37 ft to hit bottom in a 42-ft-deep channel, the scientists claim. Further, lateral forces as great as 450,000 lb or more--known as "bank suction"--can pull a ship traveling to one side of the center line of a harbor channel into the closer bank, forcing it aground.

The scientists have spent 18 mo studying ships and channels. Their work was funded by NOAA's Office of Sea Grant and the U.S. Army Corps of Engineers. From their study they have developed a computerized mathematical model that will allow engineers to determine how a vessel acts in any straight section of a restricted waterway. The model requires only that information which is readily available to engineers.

A major problem is that historically naval architects generally have not considered a ship's behavior in restricted channels in their critical design conditions. They know how a vessel--even a huge oil tanker--will act in the open sea, but things are dramatically different in a channel that is only 500 ft wide and 40 ft deep. To add to the problem, persons who design harbor channels do not have enough information to understand how a large, oceangoing vessel interacts with the water and the sides and bottom of the channel.

One phenomenon experienced by any vessel while underway is called "squat"--the lowering of the surface water around and behind a vessel. This causes the ship to lie lower--sometimes by several feet--than the surrounding, undisturbed water. Although squat occurs in the open sea, it is much more pronounced in restricted or shallow waterways, and its effects are more important. Tests at the David Taylor Naval Ship Research and Development Center in Maryland, for example, showed that a typical tanker weighing 45,000 tons and drawing 37 ft, moving at about 8 kn, will touch bottom in a channel 300 ft wide and 42 ft deep. If the channel is widened to 500 ft, the same vessel could exceed 11 kn before touching bottom.

An even more extraordinary phenomenon, which has plagued harbor pilots for years, is bank suction. Enormous forces occur when a vessel travels off the center line of a channel, which is necessary in a busy waterway. In tests by the Texas A&M scientists, lateral forces in excess of 450,000 lb tend to pull the ship to the closer bank. Pilots can counteract bank suction by adjusting rudder angle and engine speed, but in so doing they sacrifice a certain amount of control over their ships.

Such physical restrictions on vessel speed and maneuverability can severely tax the skills of harbor pilots, who must also contend with traffic, obstructions, sea, and weather in negotiating their huge charges in and out of ports.

The scientists hope their mathematical model will be used to make the operation of existing restricted waterways more economically efficient. The model could also be used to select the cheapest and most effective design for new channels and to review the best methods for harbor dredging and traffic control.

A 169-page report on this study, Mathematical Model to Predict the Behavior of Deep-Draft Vessels in Restricted Waterways, is available for $5.00 from the Department of Marine Resources Information, Center for Marine Resources, Texas A&M University, College Station, TX 77843.

SEA GRANT RESEARCH SHOWS DROWNING VICTIMS SURVIVE BETTER IN COLD WATER

People who drown in cold water are not necessarily dead--even if they have been under water for as long as 30 min.

This is the conclusion of a research project carried out under a grant from NOAA at the University of Michigan.

The study, supported by the National Sea Grant Program, was conducted by Dr. Martin J. Nemiroff, a lung disease and diving medicine specialist at the University. He reported that in 13 cases considered to be true "cold water drownings"--those in water below 70°F--9 were revived successfully without brain damage or other ill effects. All had gone beyond the traditional 4-min oxygen deprivation limit after which irreversible brain damage was thought to occur.

The most spectacular survival case was one in which an 18-yr-old boy was trapped in a submerged car in a frozen pond for 38 min. When he and his companion were brought to the surface, both had no life signs and were pronounced "dead." As the bodies were loaded into an ambulance, the boy gasped. Resuscitation was started immediately. Following 2 hr of resuscitation and 13 hr of respiratory support, the boy regained consciousness. Two weeks later he left the hospital to return to college where he now is an A student. His companion in the car, whose body made no sound and was not resuscitated, died.

According to Dr. Nemiroff, this victim and the eight others in the study were saved by the activation, after their faces were submerged, of an automatic response in mammals, called the "mammalian diving reflex," combined with the coldness of the water.

The reflex allows seagoing mammals to exist and function under water without breathing for up to 30 min. It reduces the blood supply to the skin, muscles, and other tissues which are resistant to oxygen-loss damage, and reserves the remaining blood oxygen for the brain. Cold water also reduces the oxygen need of

tissues, further lengthening survival time without external oxygen.

In another case, a physician who had been under water in a lake near Ann Arbor was resuscitated after 15 min of submersion. As with the 18-yr-old victim, the physicain suffered no mental impairment and resumed his practice.

Young children appear to stand a better chance of survival in cold water than do adults, because the "mammalian diving reflex" is more pronounced in youngsters under 3-1/2 yr. Seven of the nine survivors in the study were children under that age.

Because of the research, Dr. Nemiroff advises rescue workers and doctors not to give up too easily on cold water drowning victims, even if the victim looks dead. He or she may be cold, blue, not breathing, have no detectable pulse or heartbeat and fixed and dilated pupils, but the victim should not be presumed dead.

Resuscitation should be started immediately and maintained until the body temperature reaches normal. External heart massage and ventilation with as near 100-percent oxygen as is available should be given. The body should be warmed gradually from the inside by raising the temperature of the oxygen to 110°F with a humidifier. Defibrillations--shocking the heart into action--may not be successful until normal body temperature is reached.

These studies, carried out over a 3-yr period, involved incidents in Michigan waters. Studies of drownings and near-drownings in Florida waters, where temperatures were above 70°F, indicate that 4 min of submersion appears to be the cutoff point for brain damage and survival in such waters.

COAST GUARD ICE PATROL, 1977

The 1977 Ice Patrol was directed from the Office of Commander, International Ice Patrol at Governors Island, N.Y. Two preseason upstream iceberg surveys were conducted during late January and late February. The January mission was plagued with both severe weather conditions and aircraft mechanical problems, requiring early termination before a complete census of the iceberg population in Davis Strait and along the Labrador coast could be obtained. Those data that were obtained during this mission did indicate that the iceberg population was below normal, and the ice season would probably not have to be started any earlier than normal. In February, a nearly complete census was obtained which confirmed that there was a relative scarcity of icebergs. Only about half the normal number of bergs were sighted with only 145 medium and large icebergs south of 63°N. Using the data gathered during the preseason missions, together with sea-ice cover and oceanographic data, and assuming that meteorological and oceanographic conditions would return to normal, it was predicted that 160 ± 20 icebergs would cross 48°N. As it turned out, onshore winds persisted during much of the season and produced an extremely light sea-ice and iceberg season on the Grand Banks.

The first iceberg south of latitude 48°N was reported at 47.4°N, 50.9°W, on February 28, 1977. This berg is believed to have crossed latitude 48°N on February 25.

Ice Patrol services were initiated on March 13 as the icebergs began to exit sea ice and pose a threat to North Atlantic shipping lanes which crossed the Grand Banks. Ice Patrol forces were deployed to St. John's, Newfoundland, on March 15. It is estimated that 22 icebergs drifted south of latitude 48°N during the 1977 Ice Season. This was only slightly more than 7 percent of the 1946-77 average of 300 icebergs (table 2). This was not a record low number as there were 4 yr since 1946 (when aerial reconnaissance began) with fewer icebergs sighted: 1951 - 6; 1952 - 14; 1958 - 1; and 1966 - 0.

Table 2.--Estimated number of icebergs south of latitude 48°N

	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Total
1977 Season	0	0	0	0	0	3	7	12	0	0	0	0	22
1946-77 Total	10	2	4	11	64	264	1675	2951	2897	1751	483	100	9812
1946-77 Average	0	0	0	0	2	8	34	92	91	55	15	3	300
1900-77 Total	256	109	110	91	184	715	3177	7796	9880	5269	1679	488	29,853
1900-77 Average	3	1	1	1	2	9	41	100	128	68	22	6	382

Meteorological conditions in the Ice Patrol area and upstream along the Labrador coast during December 1976 and January 1977 showed large departures from normal, including above average temperatures, with the Icelandic Low displaced to the vicinity of Belle Isle north of Newfoundland. This produced prevailing onshore winds along the Labrador coast and much lighter-than-normal sea-ice conditions off Newfoundland and Labrador. These were the same influences that brought extremely cold weather to the eastern United States. Conditions began to normalize in February and early March. With increased northerly and northwesterly winds, icebergs and sea ice began to approach the Grand Banks. However, in April conditions began to revert to what they were earlier in the season with a weak Icelandic Low centered slightly northeast of Newfoundland. The southernmost iceberg was predicted at 45°N, 48.7°W, on April 9 before melting. The easternmost iceberg was predicted at 47°N, 45.7°W, on April 17. Onshore winds along the Labrador coast and southwesterly winds off the Newfoundland coast prevailed in April and strengthened during May as the Icelandic Low was centered over Newfoundland. This caused an increased northerly flow over the Grand Banks and increased onshore winds along the Labrador coast. Warming temperatures combined with upstream wind-driven currents resulted in a rapid retreat of sea ice to the vicinity of the Strait of Belle Isle by late May, some 2 to 3 weeks ahead of normal. Wind conditions retarded the southward drift of icebergs or, in some cases, caused them to ground along the coast. Although the predominant Low weakened some, these general conditions persisted well into June.

By June 16, only two icebergs were predicted south of latitude 49°N. Due to the unusually warm sea surface temperatures during the season, these bergs were predicted to melt before crossing 48°N. There had been no confirmed reports of ice south of 48°N since April 24 or south of 49°N since June 1. Thus, there appeared to be no further threat to the primary shipping lanes for the remainder of the year. The maritime community was notified accordingly, and the Ice Patrol terminated its services on June 17.

A postseason mission was flown to conduct a last census of icebergs south of latitude 50°N for any poten-

Figure 31.--An HC130B Hercules aircraft of the Coast Guard Ice Patrol flies over a small drydock-type iceberg. The aircraft is making a dye marker drop onto the berg. Note the smoke flare near the berg in the foreground. U.S. Coast Guard Photo.

tial threat to the Grand Banks. Severe weather conditions and persistent fog over the Grand Banks region continued to restrict effective visual reconnaissance. Effective missions (i.e., greater than 50 percent visual coverage of the assigned search area) were flown 46 out of 97 days of the season (fig. 31). Satellite-derived information provided by the National Environmental Satellite Service (NESS) increased the effectiveness and efficiency of visual reconnaissance missions. Several types of nonvisual detection devices were tested.

The USCGC EVERGREEN conducted oceanographic and research cruises in support of the Ice Patrol. The EVERGREEN conducted three operational dynamic surveys along selected Ice Patrol standard sections, successfully deployed and recovered two current meter arrays, deployed three free-drifting, satellite-positioning buoys, and made an unsuccessful attempt to recover the deep moored current meter arrays near the Tail of the Banks deployed during the 1976 Season. Additionally, EVERGREEN supported Ice Patrol research and development efforts with iceberg drift and deterioration studies and a joint penetrometer drop experiment with Ice Patrol aircraft.

LETTERS TO THE EDITOR

BLACK SEA BORA

The letter below was sent by the Master of the WASHINGTON TRADER to the Port Meteorological Officer at Nederland, Tex.

S/S WASHINGTON TRADER
Novorossiysk, U.S.S.R.
January 12, 1977

Mr. Lawrence Z. Cedotal
Port Meteorological Officer
National Weather Service, NOAA
P.O. Box 1306
Nederland, TX 77627

Dear Sir:

"Attached is not an old Indian trail through the Catskills but the barograph charts for an 8-day period as the WASHINGTON TRADER lay at anchor at Novorossiysk, a Black Sea port in the U.S.S.R., during a meteorological disturbance known locally as a "BORA." While the phenomenon is undoubtedly well documented in this part of the world, perhaps this is not so elsewhere, and its uniqueness and intensity may be of future interest to mariners intending to transit this area. The onset of a "BORA" seems brought about by a strong gradient occurring between the usual high pressure in the Siberian north and a low pressure over the sea to the south. During the period in question a large low existed in the Delta region of the eastern Mediterranean. This combined with the natural topography of the Novorossiysk area where the Caucasus chain of mountains paralleling the coast but somewhat inland veers directly to the sea.

"As indicated by the barograph (fig. 32) on the 1st and 2d of January the pressure showed a slow steady rise with light variable winds mostly from the west and northwest, and decreasing temperature. The first sharp dip in the barometer came on the afternoon of the 2d accompanied immediately by strong northeasterly winds blowing directly off the surrounding mountains with great gusting intensity, which can only be described as equalling any previous experience with our more familiar hurricane and typhoon winds, with the added feature of intense cold. A remarkable pattern of pressure fluctuation followed as it was discovered that with each sudden vertical drop in the barometer, the wind would rise reaching hurricane velocity, remain so even after the barometer flattened out, until just as suddenly and sharply the pressure would rise with an attendant decrease in the wind at times to a dead calm, as though shutting off a faucet. During the time the barometer was at this upper plateau, winds would be variable, not usually over force 4. This period might last anywhere from less than 1 hr to 12 hr until inevitably another precipitous drop in pressure would revive the strong winds.

"The sharp drop on the afternoon of the 3d brought on the longest period of foul weather that we experienced. During this time period of about 8 hr the wind was seldom if ever less than force 12 with the temperature continuing to drop to a maximum low of -15°C. Sea spray and smoke rising from the water obliterated all visibility though our location was but 1/4 mi from other anchored ships in the harbor and less than 1 mi from shore. Ice buildup as a result became considerable on the main deck and all exposed vertical surfaces to windward. Incongruously, during the entire period of the "BORA," when visibility permitted observation, the skies were generally crystal clear and cloudless, except to the south of the bay where huge billowing and churning cumulonimbus would occasionally form. At no time was there any precipitation.

"Maintaining position in the anchorage with starboard anchor out to 8 shots of chain required the use of the engines, rudder and radar. During periods of highest winds the propeller was kept turning at 30 rpm ahead, normally a speed of 6 kn with the rudder used to keep an approximate heading of 045 degrees into the wind. Radar continually advised that our distance from the shoreline of .98 mi was being maintained. Other vessels in the harbor were not so fortunate. On the evening of the 3d two Italian ships came together as the one ahead drifted down on the other. This was witnessed on our radar since, though only 1/4 mi away, they were not visible. Elsewhere a Norwegian and Dutch vessel collided before putting out to sea. Winds continued through the 4th with a final sustained burst on the evening of the 5th, finally subsiding on the 6th when we were able to dock. Unfortunately the nature of the disturbance apparently precludes any indication of its duration as local meteorological reports supplied information for a 24-hr period only. Had our docking position not been imminent, I would no doubt have joined numerous other vessels in leaving the harbor for the open sea. In hindsight this would have been preferable to remaining at the anchorage, and I strongly recommend doing so upon learning of the approach of a "BORA." I am told that hurricane winds are limited to within 25 mi of the coast as are the intensely cold temperatures.

Respectfully,

A.R. LaWare, Master
S/S WASHINGTON TRADER

P.S. Many thanks, Larry, for making the barograph available to us on our last trip to Port Arthur, as it certainly dramatized the effects of this weather phenomenon."

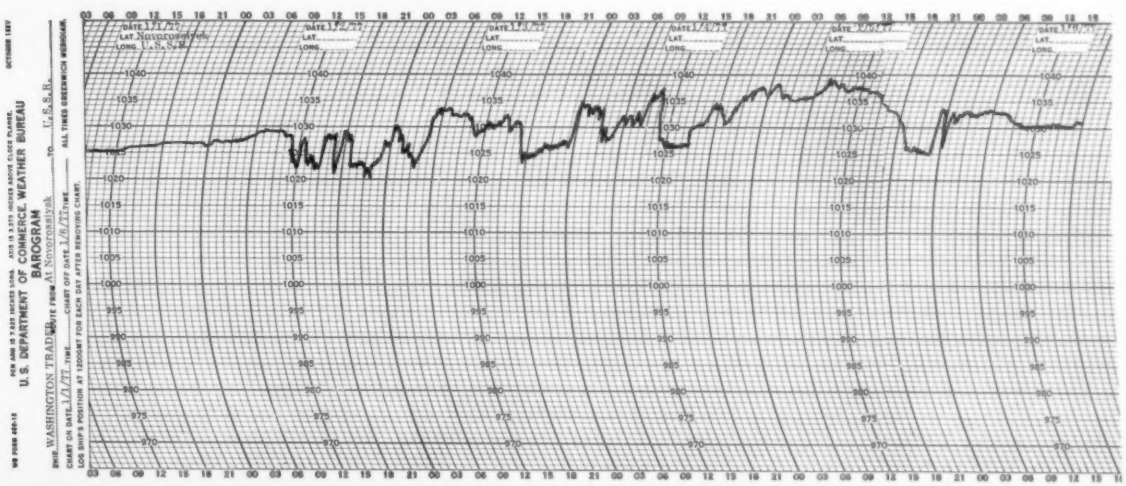

Figure 32.--The barograph from the WASHINGTON TRADER, January 1-6, 1977.

SCHOELLKOPF RECEIVES AWARD

The following Letter of Commendation and Special Service Award were presented to Captain Kristensen of the J.F. SCHOELLKOPF, JR. on August 23, 1977, for the transmission of a Special Weather Observation on Lake Erie. The observation was taken by First Mate Horace Anderson, who transmitted it to Marine Radio Station WMI in Lorain, Ohio. The Captain and First Mate said the experience was like being in a car wash with the windows and doors leaking (fig. 33).

Figure 33.--Captain Kristensen of the J.F. SCHOELLKOPF, JR. receiving the Special Service Award. From left to right: Sidney E. Smith, President, Erie Sand Steamship Co.; Capt. Kristensen; Horace Anderson, First Mate; Marvin E. Miller, MIC WSFO Cleveland; and Harry K. Goodman, Marine Manager, Erie Sand Steamship Co.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL WEATHER SERVICE
Federal Facilities Building
Cleveland Hopkins Airport
Cleveland, Ohio 44135

August 23, 1977

Captain Arn Kristensen
S/S J. F. Schoellkopf, Jr.

Dear Captain Kristensen:

On the evening of July 18, 1977 at approximately 1702 EST the following weather report was received from Marine Radio Station WMI, Lorain, Ohio:

"STR J F SCHOELLKOPF JR REPORTS AT 1700 EST THE STORM THAT WAS OFF LORAIN IS NOW OFF AVON WITH WIND GUSTS TO 100 KNOTS"

Our forecasters were watching several radar echoes over the lake and had issued a "Special Marine Warning" but they did not know the exact wind speeds or weather associated with the echoes. When your special weather report reached our office just two minutes after transmission, we immediately issued another "Special Marine Warning" for all marine interests in the area and to the east of the area where the storm was moving. The storm that produced these high winds was on a track that would put it ashore near the City of Cleveland and to the east of Cleveland. We immediately issued severe thunderstorm warnings for the counties in the storm's path. Winds were measured at 75 miles per hour at several locations when it reached shore.

Your special weather report was very important and valuable to us. It is this type of cooperation that greatly assists us in warning people of the dangers associated with storms. Lives can be saved when the public receives accurate and timely warnings. We can do a much better job when we receive reports such as the one you sent.

We are very honored to present you with a "SPECIAL SERVICE AWARD" and to say thanks for the special weather report which you sent the evening of July 18th.

Sincerely,

Marvin E. Miller
Meteorologist in Charge

MARINE WEATHER REVIEW

The SMOOTH LOG (complete with cyclone tracks [figs. 38-41], climatological data from U.S. Ocean Station and Buoys [tables 3 and 4], and gale and wave tables 5 and 6), is a definitive report on average monthly weather systems, the primary storms which affected marine areas, and late-reported ship casualties for 2 mo. The ROUGH LOG is a preliminary account of the weather for 2 more recent months, prepared as soon as the necessary meteorological analyses and other data become available. For both the SMOOTH and ROUGH LOGS, storms are discussed during the month in which they first developed. Unless stated otherwise, all winds are sustained winds and not wind gusts.

Smooth Log, North Atlantic Weather

March and April 1977

SMOOTH LOG, MARCH 1977--The paths of the low-pressure centers did not match the climatological paths very well this month, even though the configuration of the mean-pressure pattern matched very closely. The mean storm path from the Midwest to over the Great Lakes was normal, and the storms quickly dissipated northeast of the Lakes instead of continuing toward Davis Strait and Iceland. There was the normal storm path off the east coast of the United States, but it took a more easterly component

away from Newfoundland than is usual. Near 35°N the storms turned northward to generally dissipate south of Iceland. More storms than usual formed in mid-ocean to track toward Iceland.

The Icelandic Low was near 57°N, 30°W, slightly east of its normal location at 998 mb rather than the normal 1005 mb. A secondary 1007-mb LOW was just north of Norway. The Azores High at 1024 mb was normally located near 30°N, 30°W, but it was 4 mb higher in pressure. Anomalies were mainly caused by pressure differences rather than center locations. A negative 8-mb center was near 55°N, 27°W, and a positive 4-mb center was near 30°N, 30°W. Probably the most significant pressure center (1008 mb) and anomaly (-7 mb) was over the Great Plains.

As usual, the upper-air pattern was mainly zonal over the water. There was an anomalous low-pressure center south of Kap Farvel. This shifted the major trough line from a north-south orientation to northeast-southwest off the eastern coast. The Low over the Midwest was reflected in the upper air by a short-wave trough. The normal ridge over the coast of western Europe was shifted eastward.

Extratropical Cyclones--The first week of the month the weather over the water was dominated by two high-pressure areas, one over the Mediterranean Sea and the Bermuda High. The LOWs were between the two HIGHs and to the north, where they were weak and small in relative terms.

This LOW formed in a trough between the two HIGHs late on the 4th. On the 5th the FROSTFJORD found 45-kn winds near 37°N, 40°W. On the 6th the LOW combined with the circulation of two other LOWs to become a large storm heading northward. At 1200 it was 970 mb with gales to the south and west and swells up to 20 ft. At 0000 on the 7th, Ocean Weather Station Charlie measured 48-kn winds with 25-ft seas from 240°. Another LOW from off the U.S. East Coast was rapidly overtaking this one.

This was the LOW. It formed at a frontal occlusion on the 5th. It rolled rapidly around the periphery of the previous LOW with gale-force winds and moderate seas. Things picked up on the 7th. Three ships reported winds of over 60 kn. They were the FRANKFURT, NORDIC TEXAS, and TOLUCA. The seas were running up to 25 ft as reported by the EXPORT DEMOCRACY near 39°N, 38°W.

At 1200 on the 8th, this LOW overtook and absorbed the previous one with many 40-kn winds reported in the southern half of the circulation. The VANCOUVER FOREST, 900 mi south of the 962-mb center, was surfing toward the northeast on 33-ft swells. Along the front there were 20- to 30-ft waves.

On the 9th, another vicious LOW was moving eastward south of this LOW and weakening the gradient between the two. The LOW had turned toward the northwest, but it took a sudden turn to the northeast after midday on the 9th. It was gone on the 10th.

Monster of the Month--A wave formed on the 6th near Savannah, Ga., on the front that stretched southwestward from the LOW above. At 1200 on the 7th, it was over the Gulf Stream off Cape May. The TOLUCA was east of the center with 60-kn winds and 20-ft seas. By

0000 on the 9th, the circular 969-mb storm was near 43°N, 45°W. The FRANKFURT (41°N, 47°W) reported a roaring hurricane-force 70-kn wind with 59-ft seas and swells. A SHIP reported 40-kn winds and a pressure of 969.1 mb in the center of the storm.

At 1200 the SEA-LAND MARKET was 180 mi southeast of the center of the LOW sailing eastward with the aid of 60-kn winds and 25-ft seas. The ONLA was headed into giant 49-ft seas and 56-ft swells driven by 55-kn winds while 420 mi southwest of the center. The VANCOUVER FOREST (45°N, 29°W), east of the center, had 36-ft seas and swells. The HOEGH PILOT (39°N, 42°W) pounded into 46-ft seas. The high winds and seas continued with the DART AMERICA reporting 41-ft swells later in the day. At 0000 on the 10th, Ocean Weather Station Romeo measured 50-kn winds and 26-ft seas. The DART ATLANTIC was plowing into 40-ft swells, which were also battering the MUENCHEN. On the 11th the 960-mb LOW was south of Iceland and turning westward. Swells of 20 ft were still being reported as far as 1,000 mi southwest of the center. The KOSICE was near that 1,000-mi mark (43°N, 20°W) with 60-kn winds and 23-ft seas at 1200. On the 12th another LOW moved south of this LOW, and it again turned eastward to dissipate near Iceland on the 13th. The southern LOW produced winds of near 55 kn and swells of 33 ft for both the AMERICAN LEGACY and the C.P. TRADER near 48°N, 36°W. The LEON encountered 45- to 50-kn winds, seas to 20 ft, and swells to 33 ft on the 13th and 14th as she headed southwestward near 46°N, 14°W.

This was a severe storm over the North Pacific that tracked across northern Canada to move off the Labrador coast on the 13th. The C.P. TRADER ran into this storm at 0000 on the 14th and found 40-kn winds, 20-ft seas, and 38-ft swells. At that time the LOW was 982 mb near 51°N, 36°W. Later in the day the storm turned northward. Many ships were reporting gales with seas and swells in the 20-ft category. At 1200 the AMERICAN ARCHER about 40 mi south-southeast of the center, experienced 60-kn winds and 25-ft seas. On the 15th the ATLANTIC SPAN (49°N, 40°W) suffered 55-kn northerly winds with 30-ft seas. Six hours later at 1200 the seas were 39 ft and then 33 ft at 1800.

The LOW covered the shipping lanes from Newfoundland to Europe, and there were high seas from 50°N to south of 40°N. The high seas continued until the 18th with 20 ft the general height with an occasional 30 ft.

During the 16th to the 18th, the storm center wandered north and south as it gradually moved eastward. Late on the 18th, it decided on a southeasterly track, pausing near Paris for 2 days, and then dying out on the 23d on the south coast of France.

The lee of the Rocky Mountains produced this storm on the 17th. By the time it reached the East Coast it was fully developed. At 0000 on the 19th, it was off Long Island, and Ocean Weather Station Hotel had 50-kn winds at frontal passage. At 1200 the EXPORT PATRIOT was near the warm front with 50-kn southerly winds and 20-ft waves, while the LEONARD DA VINCE, south of the 968-mb center, had 52-kn westerly winds and 30-ft seas. At 1800 the AMERICAN ARCHER encountered 49-ft swells.

At 1200 on the 20th, the 970-mb LOW was off Hamilton Inlet. The ANCO TEMPLAR was about 800 mi south of the center with howling 75-kn winds. A ship south of Kap Farvel reported easterly 68-kn winds.

The storm moved through Baffin Bay on the 22d to disappear on the 23d.

An occluded front moved eastward from the lower Mississippi valley. On the 20th a wave formed at the occlusion and moved over Cape Hatteras. The SWEDISH WASA had 48-kn winds southwest of the center at 1200, and the ASIA FREIGHTER had 60-kn northwesterlies and 30-ft waves, 120 mi southwest of the 994-mb LOW at 1800. As the storm passed south of Newfoundland, it expanded. Late on the 21st, the HOEGH TRIGGER measured 55-kn winds 400 mi southwest of the center. At 0000 on the 22d, the VANCOUVER TRADER was caught by 55-kn winds from the west and 39-ft seas. Throughout the day ships were reporting winds up to 60 kn and waves to 40 ft.

On the 23d a ship reported 55-kn winds with 43-ft waves. The KOSICE was 500 mi south of the LOW with 85-kn winds. The LOW was weakening on the 24th, but it was still producing 40-kn winds and seas to 20 ft. On the 27th, it drifted ashore near Cherbourg.

Another LOW from the east slope of the Rocky Mountains formed on the 21st and was over Long Island at 979 mb at 0000 on the 23d. Winds gusted up to 75 kn with 25 in of snow in Connecticut, and Atlantic City, N.J., had 50 kn. Storm warnings were posted along the northern New England coast with gale warnings south to Cape Charles. The 10,262-ton OCEAN ENDURANCE reported a shift in cargo near 34°N, 59°W. OWS Hotel braved 50-kn winds at 0600 with no wave report, but at 1200 the waves were 23 ft. There were half a dozen reports of winds near 45 kn and/or seas to 20 ft. On the 24th the EXPORT COURIER, 350 mi south of the 978-mb center, had mild 35-kn winds, but the seas were 16 ft and the swells 33 ft. The HOEGH TRIGGER, sailing southwestward along the eastern edge of the Gulf Stream, measured 49-kn winds and 20-ft seas early on the 25th.

As the previous LOW weakened and moved eastward, this LOW expanded. Maximum waves were 25 ft on the charts of the 25th with winds generally about 40 kn. The ARTHUR MIDDLETON was near 36°N, 63°W, when hit by 60-kn westerly winds, 30-ft seas, and 34-ft swells on the 26th at 0000. On that analysis another LOW formed east of this one and took over the circulation on the 27th. That day OWS Lima suffered 45-kn easterly winds, 16-ft seas, and 26-ft swells.

This storm almost missed the month. For several days there had been a series of LOWs in a trough between the Azores High and its extension over Europe and the Bermuda High and Greenland High. Late on the 29th another LOW formed east of Newfoundland near longitude 35°W. This one quickly deepened and developed into a major storm. Its pressure was 966 mb by 1200 on the 30th. The center was near OWS Charlie, which registered a pressure of 969.6 mb with 50-kn winds. The C.P. DISCOVERER, about 200 mi to the south, had 40-kn winds blowing 23-ft seas.

On the 31st the LOW was moving northeastward. The GODAFOSS fought 50-kn winds north of Charlie and northwest of the LOW's center. The ATLANTIC SPAN was south of the center at 50°N sailing into 50-kn westerly winds and 36-ft seas. East of the center gales of 35 to 40 kn were blowing over the British Isles. Forty- to 50-kn winds continued throughout the day. OWS Lima was rocked by 25-ft waves which continued into April 1. On the 2d, the LOW moved into Scandinavia and soon was no threat to shipping.

Casualties--The 6,592-ton Greek NOSTOS VASSO ATHENE broke tow from the tug BROCOLI on the 1st near 40.5°N, 18.1°E, in heavy weather and ran aground. The 15,864-ton AMERICAN ARCHER reported heavy weather damage on the 3d. The Greek motor vessel EUROSKY sustained possible ice damage while leaving Cornerbrook, Newfoundland. A collision in fog in New York Harbor damaged both the 9,322-ton American SANTA BARBARA and the 28,570-ton Italian AMBRONIA. On the 4th an oyster dredging skipjack sank in Chesapeake Bay when she was overwhelmed by a 70-kn squall. The six fishermen aboard were lost. On the 6th, bad weather and strong currents grounded the barges HANS and NELLE (3,906 tons) under tow by the tug KWAKWANI southeast of Trinidad. The ATLANTIC SKOLL (15,751 tons) put into St. John's on the 8th to repair ice damage. The Finnish MISTRAL (15,743 tons) arrived St. Michael's on the 15th with heavy weather damage. The Belgian HASSELT (16,250 tons) grounded in dense early morning fog in the River Scheldt on the 23d.

SMOOTH LOG, APRIL 1977--As might be expected for a transition month, the storm tracks exhibited very little comparison to the normal climatology. The only track to compare was one from over the Gulf of St. Lawrence into the Labrador Sea which had minimal effect on the shipping lanes. Only one storm moved off or formed off the U.S. East Coast south of Maine. Many more storm centers than normal formed near or traversed the central ocean south of 40°N. They traveled from north to south to east. One reached Scandinavia, and another reached the Iberian Peninsula. Three centers visited the Mediterranean Sea.

The mean pressure pattern was quite different from the long-term mean. There were three low centers over the northern latitudes with the primary and deepest one at 1003 mb near Trondheim, Norway. The

other two were over the Labrador Sea. The Azores High ridged into the area between Greenland and Iceland, where the primary Low is normally positioned. The pressure over the middle latitudes was generally 4 mb higher than the climatic mean with the 1020-mb isoline encompassing the area normally covered by the 1016-mb isoline. The high-pressure center at 1026 mb was shifted nearly 10° in both latitude and longitude to 40°N, 20°W.

The primary shipping lanes were influenced by positive anomalies--the most important one being a positive 7-mb center near 50°N, 20°W. Another was a positive 5-mb center off the U.S. East Coast. A negative 9-mb center was near Stockholm.

The upper-air pattern at 700 mb closely matched the long-term mean, except the troughs and ridges were more accented. This particularly applied to the ridge west of the European coast, which in the northern latitudes was also shifted westward.

Extratropical Cyclones--The first storm of the month came from the lee side of the Rocky Mountains. On the 4th it was centered over Newfoundland at 985 mb. The ALERT and two other Canadian vessels off Halifax had 55-kn westerly winds and 20-ft waves. Later in the day the ATLANTICA MILANO had 52-kn winds and 26-ft seas and swells about 400 mi east of Cape Cod. By midday on the 5th, the LOW was battering shipping. The USCGC EVERGREEN near 43.5°N, 49°W, was tossed by 34-ft seas. The SPLIT about 100 mi away had 60-kn winds and 21-ft seas. In the far southeast quadrant a ship was hit by 55-kn winds.

A few days earlier an upper-air HIGH had broken off a ridge of high pressure over midocean and moved northward. At the same time the Greenland surface HIGH drifted southward, and this combination blocked further eastward movement of the LOW. On the 5th it turned southeastward. The ITALICA fought 60-kn winds and 20-ft seas near 40°N, 45°W. Gales up to 45 kn were the general report. At 1800 on the 6th, the GEESTLAND (35°N, 39.5°W) had 50-kn northwesterlies.

On the 7th the LOW covered the eastern half of the ocean from the African coast to 45°W and from latitude 20° to 40°N. The anomalous HIGH, centered near 55°N, 30°W, still persisted at 1043 mb. This forced another large LOW to move northward into Baffin Bay. The LASH ATLANTICO found 40-kn gales with 15-ft swells at 28.5°N, 37.6°W.

On the 8th the path of the LOW center looped counterclockwise near 31°N, 30°W. The winds were mild, but the swells were increasing to the 20- to 25-ft range. On the 9th the BORODINO at 25°N, 37°W, was tossed by 31-ft swells. On the 11th the LOW dissipated among the Canary Islands.

This storm came out of the desert southwest of New Mexico. While the center was still over the Mississippi Valley, its circulation reached the Eastern Seaboard on the 4th. At 0000 on the 6th, the 979-mb center was about 200 mi southeast of the lower tip of James Bay. The pressure gradient in the warm sector and along the front had tightened. There were strong winds along the cold front which paralleled the Gulf Stream and added to the instability. Ocean Weather Station Hotel measured 50-kn winds and 18-ft seas. The RESEARCHER was only a few miles northeast of Hotel with 45-kn gales, 12-ft seas, and 17-ft swells. Farther south along the front, EB01 reported 40-kn winds and 16-ft seas, while the PVT JOHN R. TOWLE at 34.7°N, 73.3°W, not far from EB01, found 48-kn winds, 13-ft seas, and 18-ft swells.

The HIGH, centered near Iceland, blocked further eastward movement; and the LOW, now 978 mb, turned northward into the Labrador Sea. At 1200 on the 6th, a ship near 38°N, 64°W, again at the front, had 30-ft seas.

By midday on the 7th, the LOW was centered far north over Baffin Bay near 64° and the tighter gradient was concentrated over the Labrador Sea, where there were no ship reports. On the 9th the circulation center transferred to the east coast of Greenland with the next storm.

The HIGH over the northern waters and the LOW that earlier had moved over Baffin Bay still persisted on the 8th. The circulation around the LOW had expanded to include the Greenland Sea, and a trough formed just north of Iceland. On the 9th a LOW formed in this trough near Scoresby Sound. At 0600 the POSEIDON (63°N, 25°W) found rain, 48-kn winds, and 16-ft seas. By 1200 the MINDEN, near the same position, battled 60-kn winds from the southwest and 30-ft seas which persisted through 1800. At this time this LOW became the primary cyclone, as the one over Baffin Bay disappeared. The 984-mb center moved northward on the 10th, and another center of 980 mb formed on the Greenland coast south of Scoresby Sound. The AMBER at 60°N, 35°W, and the buoy at 62°N, 29°W, both reported 45-kn gales.

The LOW moved over Iceland late on the 11th, and the TFBC off the northwest coast of Iceland found 52-kn winds. Most windspeeds were in the 40-kn category. Near 53°N, 22°W, a ship was buffeted by 25-ft seas and swells. The cyclone moved inland over Scandinavia on the 14th.

The Azores High had drifted southward to latitude 45°N, but it was still north of its normal position. Another HIGH moved off the U.S. East Coast. Late on the 11th a closed cyclonic circulation formed between the two anticyclones. The SOLON TURMAN had 40-kn southerly winds east of the front near 40°N, 39°W. At 1200 on the 12th, the LOW was 1009 mb at 39°N, 48°W. At 1800 two ships about 120 mi west of the LOW had 45-kn gales. North of the center the MANCHESTER COURAGE was sailing with 66-kn northeasterly winds.

The LOW was moving northward and on the 14th was 990 mb near 48°N, 45°W. The SANKOGRAIN (41°N, 43°W) had 55-kn westerly winds on her starboard bow. The highest seas around the storm were 23 ft. On the 0000 chart of the 15th, the LOW was turning northwestward as another LOW moved eastward off Nova Scotia. The 1200 chart showed the two combined.

This storm formed in the wake of a LOW that originated far enough south (26°N) to have been a tropical storm. Instead, it was a cold core LOW and traveled northeastward. The FROSTA (34.3°N, 47°W) was battered by 55-kn winds, 17-ft seas, and 30-ft swells just ahead of the cold front on the 17th. As the LOW moved east of Newfoundland on the 18th, it left a large area of flat gradient between 30° and 40°N. At 1200 a weak

1009-mb circulation developed in that area. It drifted eastward until the 20th when it started to intensify and move toward the northeast. At 0000 a ship reported 40 kn near the 1004-mb center at 40°N, 43°W. At 1200 Flores Island in the Azores group was raked by 50-kn winds. A ship north of the island had 20-ft waves. By 0000 on the 22d, the LOW had raced to 55°N, 20°W, but the pressure was still only 998 mb. At 0600 the NAESS TEXAS was hit by 63-kn winds from the south-southwest near the front. The storm turned eastward as it crossed the Orkney Islands and invaded Scandinavia.

There was strong, zonal upper-air flow over Newfoundland on the 22d when this cyclone developed. It raced eastward and turned to the northeast at 1200 on the 23d. At 0000 on the 24th, it was 990 mb about 100 mi south of OWS Charlie. The KAPITAN NOCHRIN at 47.5°N, 48°W, reported 52-kn northwesterly winds. Twenty-four hours later, the pressure had plunged to 968 mb almost directly over OWS Lima. At 1200 Lima measured 55-kn westerly winds and 23-ft seas. Other ships both north and south of the LOW were reporting 40- to 50-kn winds. At 1800 a ship north of the center had 52-kn winds and 25-ft seas, while one south of the center had 40 kn and 26 ft. Lima reported 23-ft seas at 0000 on the 26th. Icelandic fishing boats off the east coast were suffering 40- to 50-kn gales as the storm stalled for a day before it turned southward and dissipated.

Casualties--The 1,531-ton British-registered WHITEHORN ran aground on rocks in Galway Bay on the 1st during heavy weather. The 2,999-ton Swedish IMMEN capsized and sank in heavy weather in the Baltic Sea (58.8°N, 19.1°E) on the 3d. The crew was rescued by helicopter. The 32,269-ton American STONEWALL JACKSON was struck by barges during a storm early in the month. The Liberian tanker UNIVERSE DEFIANCE sustained a fire and explosion off the coast of Portuguese Guinea on the 16th. High winds and heavy seas were hampering tugs towing the ship to Dakar.

The BRAVO oil rig in the North Sea about 150 mi northeast of Scotland suffered a blowout on the 22d (fig. 34). The 112-man crew was evacuated as oil sprayed 180 ft into the air. Rough seas up to 20 ft hampered efforts to seal off the well. The 2,667-ton nonpropelled pontoon MULUS 1 dragged anchor in heavy weather at Az Zawiyah, Libya, and drifted onto the breakwater on the 22d. It was refloated by the tug AFON GOCH, but it capsized and was towed to deep water and sank. The British motor vessel CUNARD PRINCESS arrived in New York on the 30th with heavy weather damage.

Figure 34.--A fireboat pours enormous sprays of water over the North Sea oil rig BRAVO to prevent the blowout from igniting. Wide World Photo.

Smooth Log, North Pacific Weather

March and April 1977

SMOOTH LOG, MARCH 1977--Cyclone activity over the North Pacific was near normal this month, but it was shifted in some areas of concentration. The storm centers that normally form south and east of Japan were concentrated farther north over the southern islands and took a more easterly track than indicated by climatology. Near midocean, these paths curved sharply northeastward with the majority entering the eastern Bering Sea. Approximately one-third tracked south of the Aleutian Islands into the Gulf of Alaska. The area between Hawaii, the mainland, and south of 45°N was devoid of storm-center tracks, except for two that moved southward off the west coast of the United States. There was a secondary track from northern Manchuria into the Bering Sea.

The Pacific High at 1034 mb near 36°N, 148°W, dominated the mean-pressure chart. Its center was positioned normally, but the mean pressure was 12 mb higher than normal, resulting in a 12-mb positive anomaly center. This high pressure dominated the eastern ocean during most of the month. The double-centered Aleutian Low was shifted eastward, with the eastern center (1004 mb) over Montague Island the more intense. Climatology indicates the western center (1005 mb) over the southwest Bering Sea as the more intense. This resulted in the negative anomaly centers being over southwestern Alaska and near Great Slave Lake in northern Canada. The vast majority of the ocean, except for the eastern Bering Sea and the northern Gulf of Alaska, had higher-than-normal mean pressures.

The upper air was mainly zonal flow with a major trough east of Japan and a minor trough along the west coast of the United States. Both the high- and low-height centers were more intense than normal, with the LOW shifted northeastward from the Sea of Okhotsk to west of the Bering Strait.

Tropical storm Patsy was the first tropical cyclone this year.

Extratropical Cyclones--This storm came racing across the Yellow Sea out of China as a frontal wave on the 1st. It was not until the 3d off Tokyo that it earned its title. A Ukrainian ship was caught by 56-kn winds and 20-ft seas between the center and Honshu. At 0600 another U.S.S.R. ship was beaten by 64-kn winds north of the LOW. At 0000 on the 4th, the LOW was 960 mb near 47°N, 155°E. Fifty-kn winds were observed in the southern semicircle with 60-kn winds north of the center. Seas of 26 ft were the highest reported. The USZY was battered by 76-kn winds among the Kurile Islands. Most of these reports must have come from the Soviet fishing fleet. The KASHIMA MARU had 50-kn winds. A 1040-mb HIGH over the central ocean blocked further eastward movement of the LOW.

This LOW formed on the east side of the previous LOW, north of the HIGH, late on the 4th. On the 5th two ships plotted winds of about 60 kn. At 1800 the PRIBOY was battered by seas of 46 ft as the LOW raced eastward. Six hours later at virtually the same location (50°N, 160°W), the winds were 52 kn, seas 28 ft, and swells 39 ft. Another ship 6° longitude to the west was tossed around by 33-ft seas and swells. By 1200 on the 6th, the LOW was 968 mb over the Gulf of Alaska and appeared to be heading directly for Vancouver Island. At 0600 the LONG BEACH had reported 54-kn winds near 45°N, 140°W, and at 1200 the ATLANTIC PIONEER (47°N, 143°W) measured 49-kn winds and 25-ft waves. At 1800 the LOW turned northward. The PRESIDENT FILLMORE was near the Strait of Juan de Fuca with 45-kn southerly winds on the 7th. A Japanese ship was riding out 26-ft seas less than 100 mi from the low center, and EB19 reported 23-ft seas. The MEDELENA was over 1,000 mi southwest of the LOW with 64-kn westerly winds. The LOW was filling as it crossed the Alaska coast on the 8th and turned eastward across Canada.

This storm also formed in a sharp trough on the periphery of the first LOW of this month. On the 5th it was 996 mb near 42°N, 164°E. The PRESIDENT TAFT was south of the trough line at 0600 fighting 55-kn winds and 30-ft seas. At 1200 the ORIENTAL COMMANDER (36°N, 155°E) had 15-ft seas and 30-ft swells at the trough line. By 1200 on the 6th, the LOW was 982 mb at 54°N, 177°W. The VIOLET near 50°N, 167°W, measured 45-kn winds and 33-ft swells. The VAN WARRIOR was about 80 mi closer to the center with winds estimated at 55 kn. On the 7th at 0600 the ORIENTAL SOVEREIGN was less than 100 mi southwest of the 990-mb storm center (57°N, 166°W) with measured 45-kn winds, 25-ft seas, and 33-ft swells. Late that day the storm stalled over Bristol Bay.

This short-wave LOW moved around the periphery of the major circulation and did not develop very large. It started late on the 5th in the Eastern Hemisphere. The LOW was racing eastward at 50 kn on the 7th. It slowed to about 30 kn on the 8th with a few gale-force winds. As it approached the coastline late on the 8th, it deepened significantly to 978 mb. The SAMUEL S. at 44.5°N, 135.3°W, was headed into 55-kn westerly winds with 23-ft seas. The AGANO MARU was closer to the coast with 46-kn southwesterlies and 33-ft swells. At 0600 on the 9th, the center crossed the coast and lost much of its power over the mountains, but the CHANTAR had 56-kn winds and 30-ft seas off the Oregon coast.

Two large areas of high pressure dominated the ocean along latitudes 30° to 35°. A weak front separated the two. At 1800 on the 8th, a wave was analyzed on the front as the two HIGHs moved eastward. By 0000 on the 9th, the storm had deepened to 986 mb as it slipped toward the north out of the grip of the HIGHs. Gales of 35 to 40 kn were now blowing. The LOW was well into the Gulf of Alaska by 1200 on the 10th, when the SEA-LAND EXCHANGE found 48-kn winds. At 1800

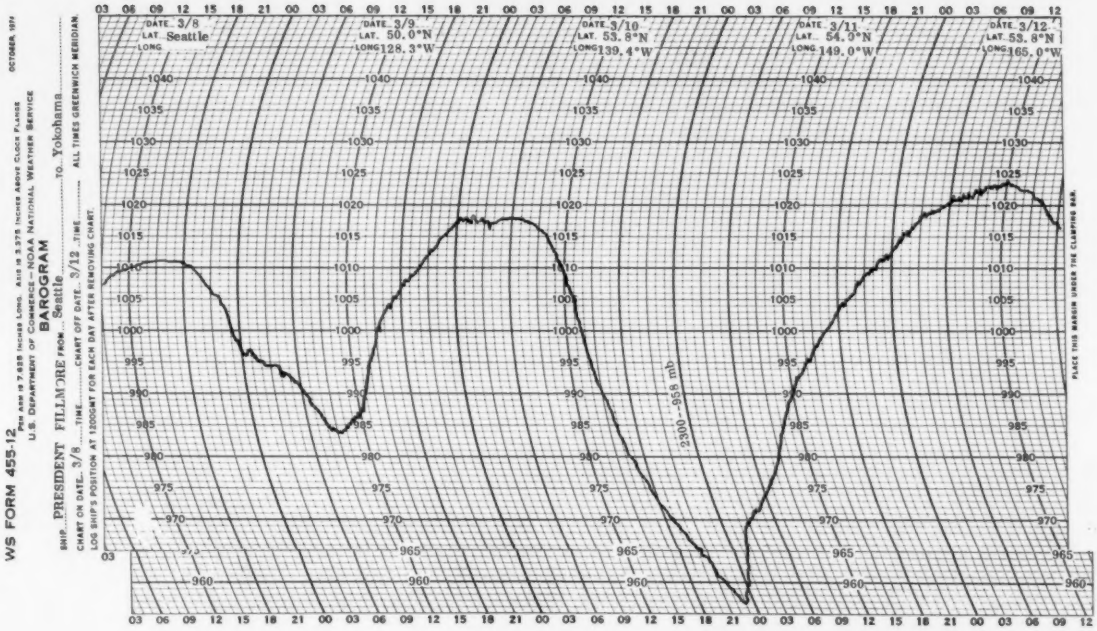
WS FORM 455-12
U.S. DEPARTMENT OF COMMERCE — NOAA NATIONAL WEATHER SERVICE
BAROGRAM
SHIP PRESIDENT FILLMORE FROM Seattle TO Yokohama
CHART ON DATE 3/8 TIME ALL TIMES GREENWICH MERIDIAN
LOG SHIP'S POSITION AT 1200GMT FOR EACH DAY AFTER REMOVING CHART
CHART OFF DATE 3/12 TIME
DATE 3/8 LAT Seattle LONG
DATE 3/9 LAT 50.0°N LONG 128.3°W
DATE 3/10 LAT 53.8°N LONG 139.4°W
DATE 3/11 LAT 54.0°N LONG 149.0°W
DATE 3/12 LAT 53.8°N LONG 165.0°W
958 mb
2300
PLACE THIS MARGIN UNDER THE CLAMPING BAR

Figure 35.--The barograph of the PRESIDENT FILLMORE.

the SANTA CLARA (52.3°N, 137.9°W), 300 mi east of the center, was tossed by 55-kn southerly winds and 39-ft swells. On the 11th at 0000, the LOW was 956 mb at 55°N, 144°W. The SANTA CLARA and GALVESTON were within a few miles of each other near 52°N, 137°W, with 60-kn southerly winds driving 33-ft seas and 41-ft swells. Six hours later, the PRESIDENT FILLMORE, south of the center, had 50-kn westerlies with 33-ft seas and swells. The PRESIDENT FILLMORE was sailing westward on the 10th and 11th and passed very near the center of the LOW as indicated by the 958-mb reading of the barograph at 2300 (fig. 35). At 0600 on the 11th she experienced winds of 50 kn, 33-ft seas, and 34-ft swells. The high seas and swells continued through 0000 on the 12th.

After midday on the 11th, the storm suddenly turned southeastward. Ocean Weather Station Papa was tossed by 33-ft seas, and the NEWARK off Sitka had 60-kn winds with waves of 23 ft, while a Japanese ship was washed by 33-ft seas. As the storm moved southward, it weakened and decreased in size. A large 1047-mb HIGH, centered near 42°N, 152°W, was pressing against the coast. There were high swells on the eastern side of the HIGH. The LEO at 50°N, 136°W, was battered by 31-ft swells. Late on the 13th, the LOW was squeezed out of existence.

The storm factory off Japan manufactured this storm. It left the assembly line late on the 11th. The LOW traveled eastward with a 1030-mb HIGH pushing and the 1047-mb Pacific High slowly retreating toward the coast. The VAN HAWK, west of the storm, radioed 56-kn northerly winds on the 13th. Later in the day, the storm turned northeastward and deepened rapidly. At 0000 on the 14th, the LOW was 984 mb near 41°N, 178°E. The LAKE PALOURDE was pounded by 66-kn winds 700 mi southeast of the center, while the PEARL VENTURE and ATLANTIC PIONEER were swept by 60- and 55-kn winds, respectively, in the southwest quadrant. Two ships both east and west of the center reported 30-ft swells.

The storm center crossed over Atka Island early on the 15th into the Bering Sea. The pressure at that time was 962 mb. Gale force winds were reported in all quadrants with snow showers in the northern area. At 1200 the TIRASPOL, about 200 mi west of the 960-mb center, was suffering with 55-kn freezing winds and 30-ft seas. On the 17th, the weakening storm crossed onto the Seward Peninsula.

There were several LOWs or frontal waves southwest of the LOW described above. This was one of them. It originated on the 15th and followed the zonal flow, turning northeastward on the 16th as it encountered the large, stubborn Pacific High. There were isolated minimal gale reports and seas to 15 ft. At 1200 on the 17th, the 998-mb LOW was near 46°N, 176°W. A front trailed to the south to approximately 35°N and then curved southwestward and westward. The ERRADALE was sailing eastward near 31°N, 179°W. The following comments on the passing of the front and an outstanding sketch of the radar scope by Third Officer Judson were given to the Port Meteorological Officer at Houston, Tex.

> 0900 17 March 1977. Clouds forming in the SW, light drizzle experienced. 0910. Windspeed increasing from SW, sky completely overcast (stratus). 0920. Heavy continuous rain, visibility 1-2 mi, radar switched on due to reduced vis., V/L encounters cold front which can be clearly seen upon the radar screen, wind veers to W force 8.

1015. Visibility increasing, sky completely overcast, light continuous rain, approximate movement of front nearly 20-25 kn. 1045. Wind NW 14 kn, barometer steady 1013.0 mb. 1130. Diagram of cold front as seen on radar. 1400. Barometer starts rising, cold front passes ship, position of ship at time of obs. 31°32'N, 179°25'W, course of V/L 090°(T) x 15 kn, temp. 14.2°C, barometer 1013.6 mb.

On the 18th the LOW was diverted into the Bering Sea. The PRIAMURYE had 52-kn winds west of the center. The ZENKOREN MARU was very near the center of the 990-mb LOW in the Bering Sea on the 19th. The wind value could not be read because of the analysis, but the swell report of 36 ft was clear. The Pribilof Islands measured 45-kn winds. There were 15- to 20-ft swell reports in the southeast quadrant. The LOW followed the Aleutian Island chain, dissipating late that day.

A series of frontal waves were rippling along a front that had been quasi-stationary south of Japan for about a week. One of these developed enough to be identifiable from the 19th to the 22d, and traveled to near midocean before dissipating. On the 21st the SEA-LAND MCLEAN found 50-kn winds just north of this center. Late on the 21st a LOW developed in a trough north of the front. By the 23d this LOW was the major LOW and center of circulation. The AGANO MARU and the VOLNA were in the vicinity of 37°N, 159°E, with 50-kn winds and seas to 26 ft. On the 24th the LOW had a pressure of 975 mb near 49°N, 180°. The A8ZH was 700 mi to the southwest with 50-kn winds and seas and swells of 26 ft. A ship about 300 mi west of the center had snow driven by 40-kn winds. The seas were 20 ft. The LOW crossed into the Bering Sea and paralleled the Aleutians (fig. 36). On the 25th the U.S. Coast Guard cutter MELLON, south of Dutch Harbor, was swept by 45-kn winds and 10-ft seas on her port. On the 26th the LOW paralleled the southern Alaska coast and moved ashore near Yakutat on the 27th. At 0000 a ship near 54°N, 151°W, reported 33-ft seas. The identity and windspeed were not clear on the chart.

Tropical Cyclones, Western Pacific--Tropical storm Patsy, the first of the season, appeared as a tropical depression on the 23d near 3°N, 165°E. Her northwestward course took her through the Caroline Islands. She reached tropical storm strength on the 28th just west of Ngatik Atoll. Patsy generated 50-kn winds for a short while on the 28th and early on the 29th. She passed about 120 mi northeast of Truk Island on the 30th, shortly before falling to tropical depression strength. The following day she dissipated.

Casualties--The 754-ton ferry MAN TACK sank after a collision in fog with the hydrofoil FLYING ALBATROSS near Hong Kong on the 2d. On the 3d the photograph in figure 37 was taken near Neah Bay, Wash. It shows the former U.S. Navy cargo transport GENERAL MEIGS which broke away while under tow to the Puget Sound Naval Shipyard for mothballing in the winter of 1971. The EASTERN ROSE (16,654 tons) and 40,404-ton PETRA collided in a snowstorm on the 4th while off Cape Shio. The EASTERN ROSE sank

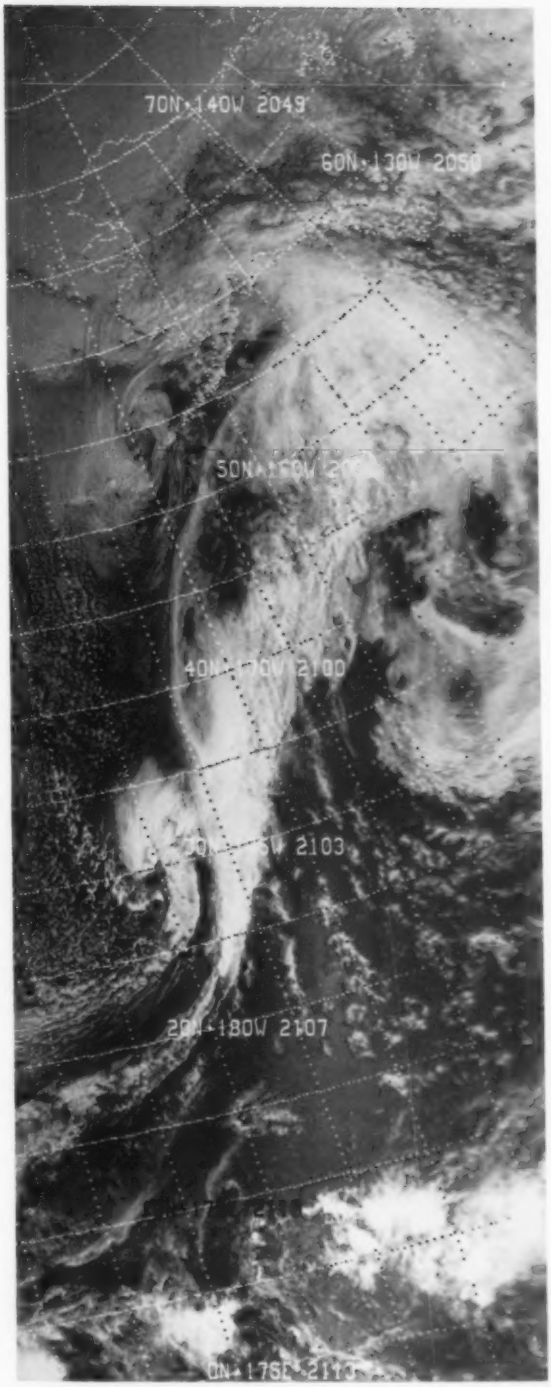

Figure 36.--At this time late on the 24th the LOW is near 54°N, 168°W. A trough and the front stretch southward to another LOW which formed just west of the front.

Figure 37.--A part of the wrecked GENERAL MEIGS rolls with the waves on the rocky beach of Neah Bay. It was not clear whether the ship recently washed up on the beach or was uncovered or what. Wide World Photo.

about an hour later. The PETRA rescued 16 survivors from a rubber boat, 7 were rescued by freighters, and 2 were killed. The 650-ton tanker SLAMET IX broke her anchor chain on the 8th during strong seas at Tanjung Priok and went onto the breakwater. The CALIFORNIAN was at Honolulu on the 15th with damage after being struck by a huge wave on the 13th. The drilling rig INTEROCEAN 1 was blown aground near Nasa Bay, Japan, on the 23d. The crew was rescued. The 908-ton Korean TONGYANG No. 52sank at 33.5°N, 136°E, after a collision in heavy seas on the 30th with the 9,858-ton Greek PROTOKLITOS. Two crewmen died and 19 were missing.

SMOOTH LOG, APRIL 1977--This was a busy month for cyclone centers across the North Pacific. The storms were generally not exceptionally deep, but there were more of them than usual. The storms out of the Sea of Japan followed the usual northeasterly track to and along the Aleutian Islands. Another group that formed over and south of Honshu took an easterly path to midocean. There was an anomalous group of storms over the eastern ocean off the U.S. West Coast during the first and last weeks of the month.

The mean pressure pattern had the normal configuration--an elongated, multicentered High near 35°N and a Low near 55°N. The normal 1012-mb isobar enclosed four 1009- and 1010-mb LOW centers between latitudes 50° and 60°N between lower Alaska and the Sea of Okhotsk. The Pacific High usually has three centers from 1021 to 1023 mb along approximately 33°N. This month, however, there were only two LOWs--a 1009 mb over the Sea of Okhotsk and a 1007 mb near Kodiak Island. There were two high-pressure centers, 1027 mb near 33°N, 175°W, and 1025 mb near 32°N, 147°W.

The anomaly centers were not large and were centered near the pressure centers. A positive area ridged up into the Bering Sea from the Pacific High.

The upper-air pattern at 700 mb exhibited more of a difference from climatology than the surface. There was a closed LOW over the Sea of Okhotsk where normally there is only a shallow trough. A sharp trough extended from the Bering Strait southeastward over Bristol Bay paralleling the U.S. West Coast. This helped accentuate the ridge over the coastal mountains of North America. A large positive anomaly covered the northern United States and southern Canada.

Extratropical Cyclones--At the beginning of the month a large center of high pressure was stationary off the U.S. West Coast, forcing many cyclones on a northerly track. One of these formed on a north-south-oriented front between that HIGH and another over the central ocean at 0600 on the 2d. At 1800 the NEPTUNE TOPAZ

had 45-kn easterly winds north of the center near 40°N, 155°W. By 1200 on the 3d, the 1004-mb Low was near 44°N, 153°W, and the NEPTUNE TOPAZ now had 45-kn southeasterly winds pounding her starboard. The PRESIDENT MADISON was near 37°N, 152°W, south of another small LOW, with 45-kn winds and 25-ft seas. At 1800 the BIBI fought 50-kn gales.

At 0000 on the 4th, the PACGLORY reported 26-ft seas and swells. By 1200 the pressure of the LOW had plunged to 977 mb over the Gulf of Alaska. Gales of 40 to 45 kn were blowing in the southeast quadrant. As the LOW moved across the Alaska Peninsula, it curved southward and again crossed into the Gulf where it died on the 6th.

Late on the 2d a LOW formed near the occlusion of a front near midocean at 44°N, 173°E. This cyclone moved east-southeastward, an odd direction for this area of the ocean. The HOYO MARU was north of the 1013-mb center with 26-ft easterly swells. A ship some distance west of the center reported 41-ft seas and swells. As the storm moved eastward on the 3d and 4th, the HIGH off the U.S. West Coast was moving northward and weakening. At 1800 the PRESIDENT MADISON measured 65-kn winds from 300° with seas of 38 ft near 36°N, 163°W. The high winds and seas continued as she slowly sailed southwestward; at 0000 on the 5th, they were 55 kn and 30 ft.

Late on the 6th, the LOW turned north-northeastward. The ORIENTAL EDUCATOR was 350 mi southwest of the center with 46-kn southwesterly winds and 18-ft waves. As the storm approached Vancouver Island, the gradient tightened, and on the 8th a ship near 53°N, 143°W, reported 74-kn winds. Later in the day the track turned eastward, and the storm crossed inland.

On the 5th a cold HIGH developed over the Texas-New Mexico area and moved southeastward over the Gulf of Mexico. On the 6th, the RICE QUEEN found 45-kn northerly Tehuantepec winds with 20-ft seas over the Gulf of Tehuantepec.

Late on the 6th there was an area of weak low pressure with two weak LOWs south of Kamchatka. On the 7th, another LOW formed south of the first two and by 1200 had taken over the circulation at 990 mb near 46°N, 169°E. The WAKAURA MARU, 250 mi south of the LOW, reported 45-kn gales. The VAN ENTERPRISE was near 52°N, 168°W, with 70-kn winds on the 8th. At 1200 another ship fought 60-kn winds north of the Aleutians. On the 9th the highest wind reported directly associated with the LOW was 50 kn south of the center. There were three ship reports early on the 9th along the North American coast which were indirectly associated with the LOW. They were the NEWARK and SEAFAN, near 50°N, 128°W, with 40- to 45-kn winds and 13-ft waves, and the S.P. LEE (37°N, 123°W) with 53-kn winds. The storm moved ashore over Cook Inlet on the 10th.

A frontal wave developed over the East China Sea on the 8th. It moved eastward with very little change until the 12th over midocean. At 0600 the PACIFIC BEAR was near 40°N, 174°W, with 50-kn southeasterly winds. At 1200 she had 20-ft seas. Early on the 13th a trough was moving through the southwest quadrant. A ship reported 28-ft swells just behind the trough line. On the 14th the LOW moved into the Gulf of Alaska at 982 mb. At 1200 the MONTIRON (53°N, 137°W) measured 48-kn winds southeast of the center. At 0600 on the 15th, her seas were 17 ft with 36-ft swells from the southwest as the LOW passed to the north. The VAN WARRIOR was about 150 mi south of the 974-mb center with 45-kn southwesterly winds. At 0600 the ZENKOREN MARU found 33-ft swells in the same general area. The SEIAN MARU (50°N, 140°W) had 40-kn winds and 26-ft swells at 1800. The MONTIRON and NEWARK were both about 200 mi south of the LOW with 40- and 50-kn winds and 31- and 26-ft swells, respectively. On the 17th the LOW crossed into southeastern Alaska and dissipated.

This storm came from western China and was very weak until it found the fertile coastal region and the Sea of Japan. When it moved across the Tartar Strait late on the 18th, it was a large 982-mb storm. At 1800 on the 17th, the PELAMIDA was north of Hokkaido with 60-kn winds. The LOW moved slowly eastward across the Sea of Okhotsk. A ship southeast of Ostrov Simushir contended with 48-kn southeasterlies.

As the storm crossed the Sea of Okhotsk, its pressure reached 968 mb, and a USSR ship in the Kurile Basin found 50-kn winds. The ALLISON CONWAY (51°N, 166°E) had 23-ft swells. On the 24th the storm crossed into the frozen Chukchi Sea.

This storm tracked out of Mongolia and crossed the Tartar Strait late on the 22d. Like the previous storm, it grew rapidly as its circulation reached the Sea of Japan. It treated Russian fishing vessels on the Sea of Okhotsk to 45-kn gales and near freezing temperatures on the 23d and 24th. The VAN WARRIOR was caught by 50-kn northwesterly winds 400 mi southwest of the 980-mb LOW at 47°N, 155°E, at 0600 on the 24th. At 1800 the MONTIRON was now near 44°N, 153°E, and measured 48-kn northwesterly winds driving 30-ft seas and 36-ft swells. Six hours later, winds were 43 kn and seas and swells had dropped to 18 and 28 ft, respectively.

At 0000 on the 25th, the VAN WARRIOR, moving southwestward away from the storm, ran into higher 60-kn winds. Other ships in the area were not finding the winds as strong, but 25- to 33-ft waves were measured. At 1200 the SEIAN MARU (43.4°N, 161.8°E) had 40-kn westerly winds, 16-ft seas, and 33-ft swells.

On the 26th the storm started to weaken and broke up into multiple centers. The original LOW decayed late that day, and the LOW to the southwest became the primary storm. The winds south of this center were blowing at nearly 40 kn, with swells running around 16 ft.

Casualties--The 46,384-ton Panamanian-registered tanker ASTRO LEO and 2,711-ton IKUSHUN MARU collided in heavy rains and winds off Matsuyama on the 6th. Both vessels were damaged with spillage of oil and fires on both vessels and the sea. The crew of the ASTRO LEO abandoned ship, but both fires were extinguished and both vessels towed to port.

Principal Tracks of Centers of Cyclones at Sea Level, North Atlantic

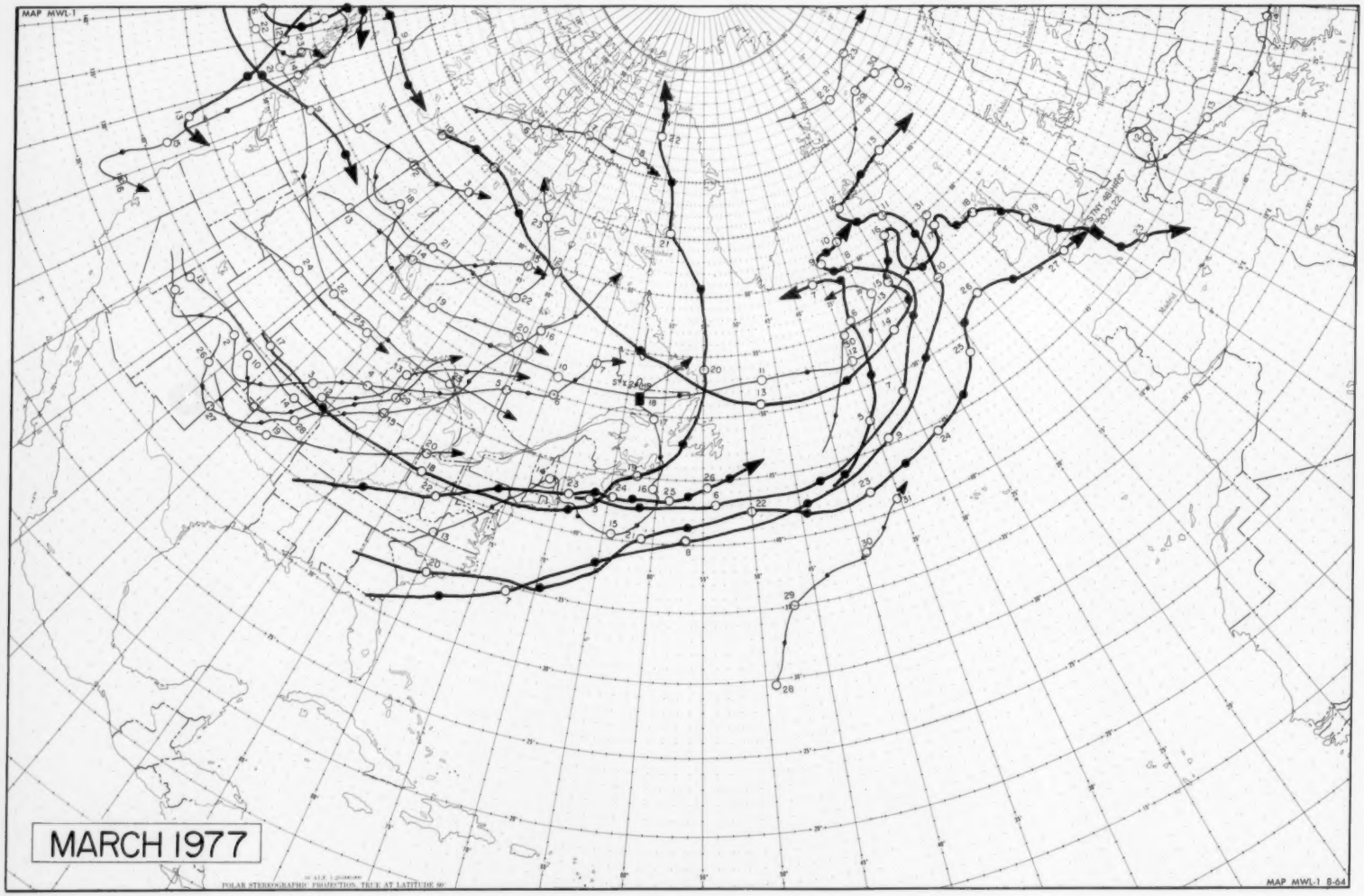

Figure 38. --Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Atlantic

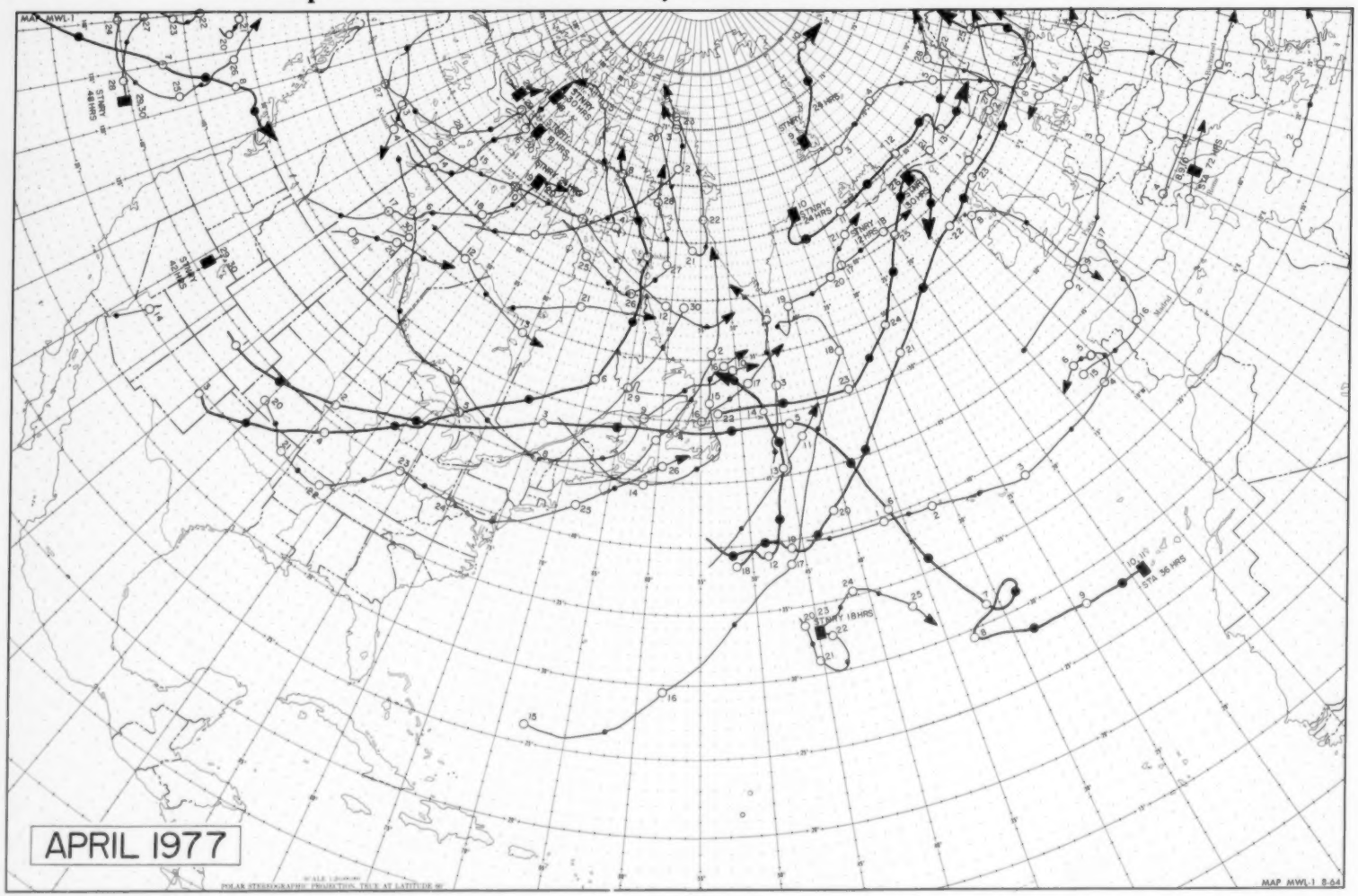

Figure 39. -- Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Pacific

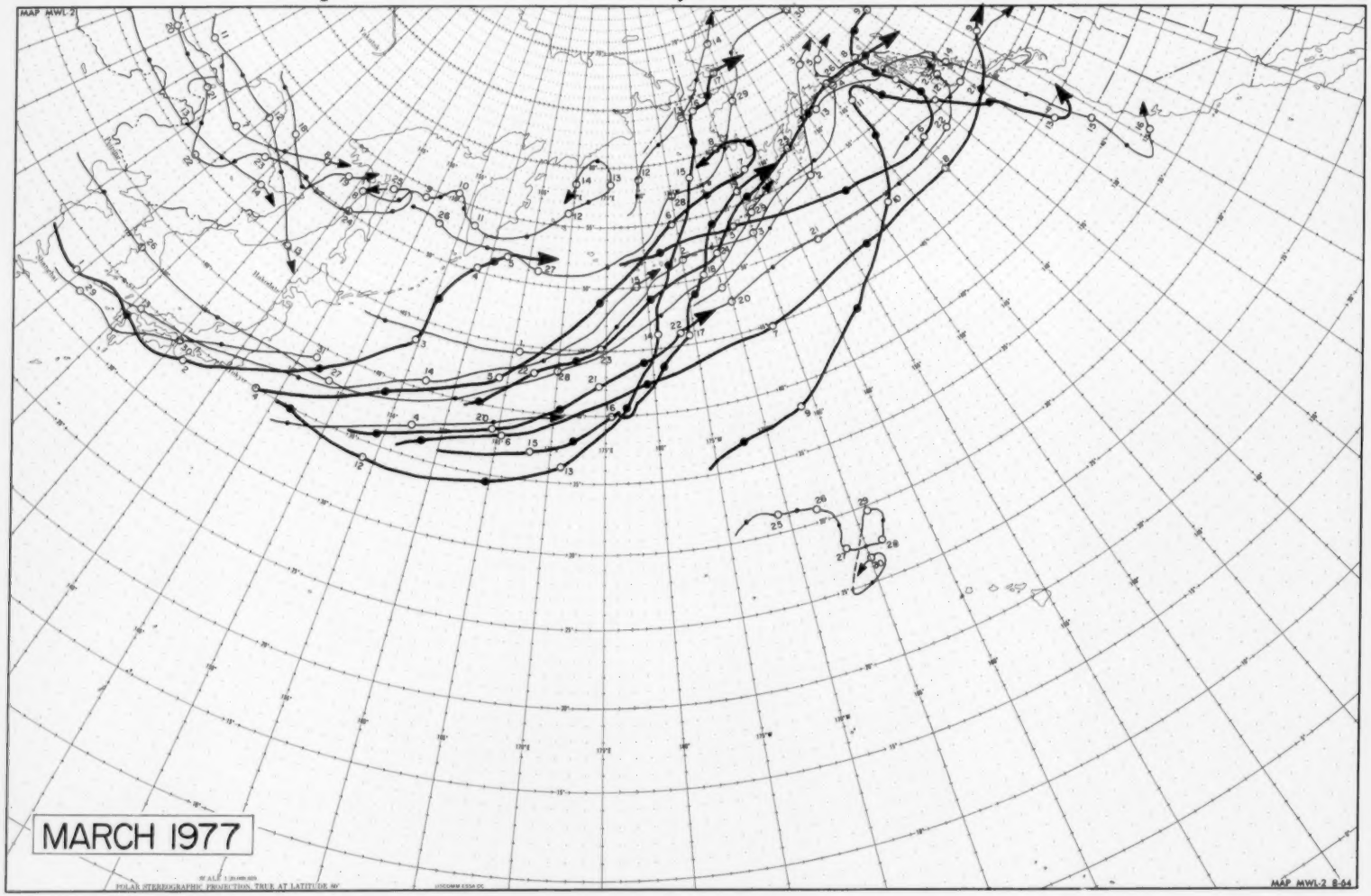

Figure 40. --Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Pacific

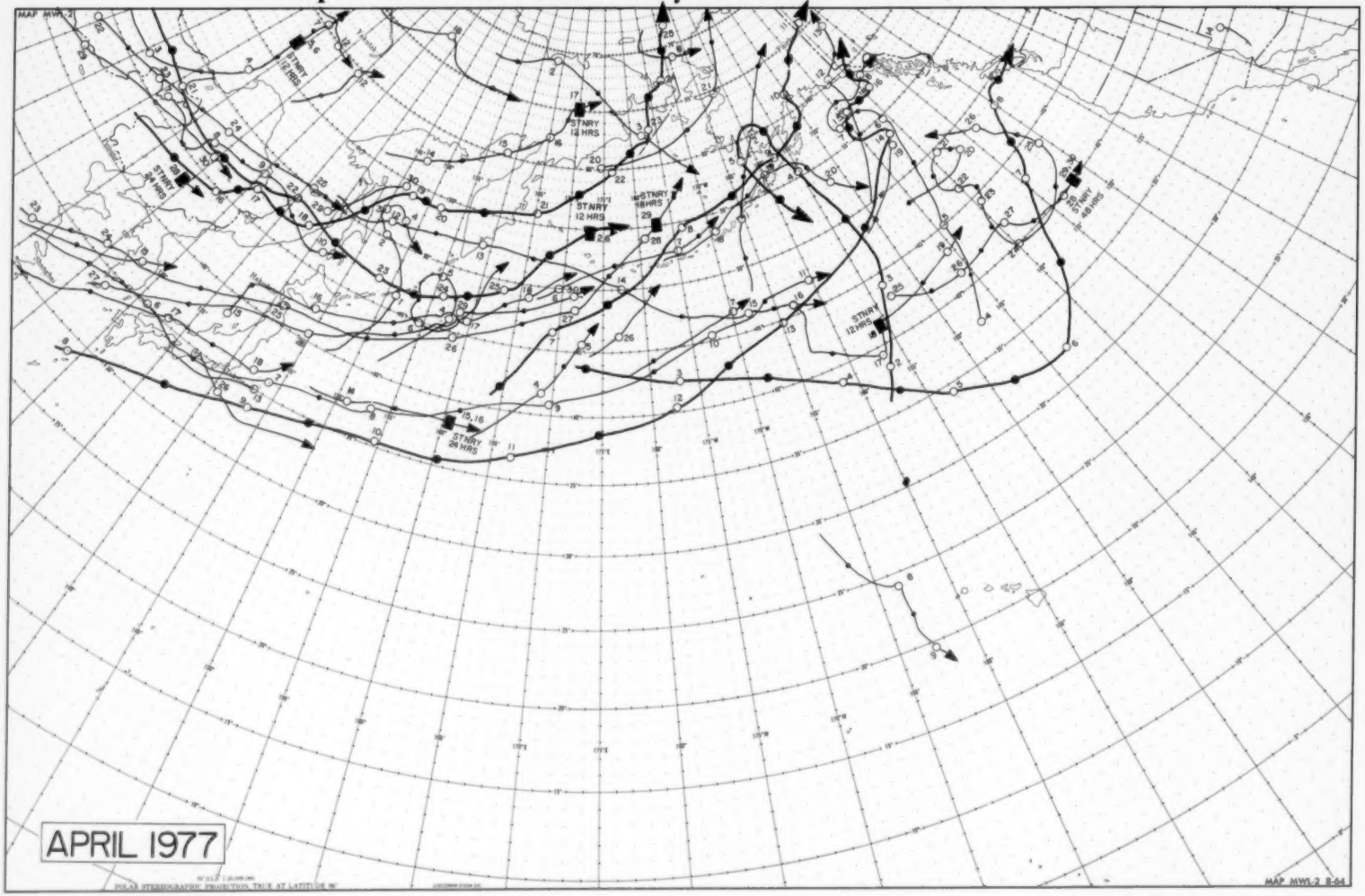

Figure 41. -- Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Table 3
U. S. Ocean Weather Station Climatological Data, North Atlantic

Ocean Weather Station 'HOTEL' 38°00'N 71°00'W **March and April, 1977**

MEANS AND EXTREMES

MONTH	DRY BULB TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	DEW-POINT TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	SEA TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	AIR-SEA TEMP DIFFERENCE (°C) MIN	DA HR	MEAN	MAX	DA HR
MAR	3.9	29 04	12.3	20.1	05 06	- 3.4	20 12	0.7	17.5	19 00	9.2	22 03	17.2	22.9	23 00	-14.7	02 18	- 4.9	4.3	18 21
APR							INSUFFICIENT					DATA								

MONTH	MEANS AND EXTREMES PRESSURE (MB) MIN	DA HR	MEAN	MAX	DA HR	PERCENTAGE FREQUENCY OF CLOUD AMOUNT (OKTAS) TOTAL CLOUD 0-2	3-5	6-7	8 & OBSC	LOW CLOUD 0-2	3-5	6-7	8 & OBSC	DAYS WITH SPECIFIED WEATHER RAIN OR PCPN	DRZL	SNOW	TSTM	VSBY <1KM **	WIND (KTS) ≥34	≥48	≥64	COMP OB DAYS	SOBS WITH PCPN	NO OF OBS
MAR	988.4	19 00	1015.9	1031.2	09 15	18.1	19.7	21.8	40.3	39.9	25.6	21.8	12.6	19	15	0	1	0	9	4	0	28	10.1	238
APR							INSUFFICIENT					DATA												

** VV-90-93 AND/OR W=4 COMP OB DAYS=COMPLETE OB DAYS

Wind

MAR WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.0	1.4	4.0	3.5	1.7	.0	10.5	22.0
NE	.4	3.7	2.7	.4	.8	.0	8.1	13.2
E	.0	1.2	.0	.0	.0	.0	1.2	7.5
SE	.4	.8	2.3	.4	.1	.1	3.9	15.1
S	.4	.7	3.0	5.1	1.2	.3	10.8	23.8
SW	.0	4.8	5.4	2.1	.4	.4	12.9	15.5
W	.0	3.2	8.7	2.2	1.9	.4	16.4	19.5
NW	.8	2.0	12.9	11.4	8.2	.0	34.6	24.4
CALM	1.7	.0	.0	.0	.0	.0	1.7	.0
TOTAL	2.9	17.2	39.1	25.2	14.3	1.3	100.0	20.2

NUMBER OF OBS 238 MAX WIND DIR 160 SPEED 60 DA HR 22 2220 VECTOR SPEED 10.4 MEAN DIR 297 (DIR IN DEGREES)

APR WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N								
NE								
E								
SE			INSUFFICIENT DATA					
S								
SW								
W								
NW								
CALM								
TOTAL								

NUMBER OF OBS MAX WIND DIR SPEED DA HR VECTOR SPEED MEAN DIR (DIR IN DEGREES)

Wave

MAR WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.0	1.9	2.0	2.9	1.9	.6	.0	.0	9.3
NE	1.3	4.0	1.7	.8	.4	.0	.0	.0	8.2
E	.0	1.2	.0	.0	.0	.0	.0	.0	1.2
SE	.0	3.4	.2	.1	.2	.0	.0	.0	3.9
S	1.4	7.4	4.5	4.3	.6	.0	.0	.0	18.2
SW	1.1	5.8	1.7	1.5	1.3	.0	.0	.0	11.2
W	2.2	4.3	3.5	.0	1.1	1.3	.0	.0	12.3
NW	.0	8.6	11.7	7.8	4.8	5.3	.0	.0	39.7
IND	.0	.0	.0	.0	.0	.0	.0	.0	.0
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	5.9	36.5	25.2	17.2	10.1	7.1	.0	.0	100.0

NUMBER OF OBS 238 IND=INDETERMINATE

APR WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-3.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N									
NE									
E									
SE			INSUFFICIENT DATA						
S									
SW									
W									
NW									
IND									
CALM									
TOTAL									

NUMBER OF OBS IND=INDETERMINATE

MAR WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	4.6	27.3	6.7	.4	.0	.0	.0	.0	39.1
6-7	1.3	7.1	17.6	9.7	5.9	1.3	.0	.0	42.9
8-9	.0	.0	.8	7.1	4.2	5.9	.0	.0	18.1
10-11	.0	.0	.0	.0	.0	.0	.0	.0	.0
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	5.9	34.5	25.2	17.2	10.1	7.1	.0	.0	100.0

NUMBER OF OBS 238 MAX WAVE HEIGHT HGT 7.0 PER 7 DIR 280 TYPE SEA DA HR 23 09 IND=INDETERMINATE (DIR IN DEGREES)

APR WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6									
6-7									
8-9									
10-11			INSUFFICIENT DATA						
12-13									
>13									
IND									
TOTAL									

NUMBER OF OBS MAX WAVE HEIGHT HGT PER DIR TYPE DA HR IND=INDETERMINATE (DIR IN DEGREES)

*ALSO OCCURRED ON PREVIOUS OBSERVATIONS

For each observation, the higher wave of the sea/swell group was selected for summarization; if heights were equal, the wave with the longer period was selected; if periods were also equal, the sea wave was used.

Table 4
U. S. Ocean Buoy Climatological Data
March and April 1977

MARCH — DATA SUMMARY — EB01
AVERAGE LATITUDE 35.0N — AVERAGE LONGITUDE 072.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	00.3	(02 21)	15.9	21.6	(31 21)	247	31
SEA TEMP (DEG C)	19.2	(28 12)	19.8	20.6	(31 21)	247	31
AIR-SEA TEMP (DEG C)	-09.1	(25 12)	-03.1	03.0	(22 21)	247	31
PRESSURE (MBAR)	0997.3	(19 00)	1017.3	1031.8	(03 15)	247	31

WIND — % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N							7.7	15.2
NE		.4	1.6	4.0	1.6		7.7	15.2
E			.8	1.2	.4		2.4	14.3
SE			1.2	6.9	.4	.4	8.9	16.6
S		.4	1.2	5.3	1.6		8.5	15.1
SW			2.0	8.1	5.7	.4	16.2	19.8
W		.8		4.0	8.9	.4	14.2	19.1
NW		.4	1.6	3.6	5.3	1.6	12.5	22.0
CALM		2.0	3.6	11.7	12.1	.8	30.4	19.1
TOTAL		.4					.4	
		4.5	12.1	43.7	36.0	3.6	100.0	18.8

MAX WIND: SPEED: 38 KNOTS; DIRECTION: 110 DEG; DAY: 22; HOUR: 12

NO. OF OBS: 247

WAVES — % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 190

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY		36.1	31.0	16.0	16.5	.5			2.0M	6.0M (23 00)

APRIL — DATA SUMMARY — EB01
AVERAGE LATITUDE 35.0N — AVERAGE LONGITUDE 073.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	10.6	(30 09)	18.8	25.3	(20 21)	240	30
SEA TEMP (DEG C)	20.0	(01 18)	22.2	24.4	(29 21)	240	30
AIR-SEA TEMP (DEG C)	-11.3	(10 08)	-03.4	00.7	(04 00)	240	30
PRESSURE (MBAR)	1002.8	(25 18)	1018.2	1031.4	(11 15)	239	30

WIND — % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N							18.8	13.3
NE		.4	5.8	1.3	.8		8.3	10.4
E			.4	.8			2.1	8.8
SE			.4				.4	5.0
S			.4	6.0	5.4	1.7	13.9	22.9
SW			1.7	14.2	15.1	.8	31.8	20.7
W			2.5	11.3	9.4		23.2	19.0
NW			2.5	2.1	.4		5.0	12.0
CALM		.8					.8	.0
TOTAL		1.7	16.7	49.0	30.1	2.5	100.0	17.7

MAX WIND: SPEED: 40 KNOTS; DIRECTION: 210 DEG; DAY: 06; HOUR: 00

NO. OF OBS: 239

WAVES — % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 240

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY		96.8	93.7	8.3	4.2				1.0M	5.0M (06 00)

MARCH — DATA SUMMARY — EB03
AVERAGE LATITUDE 56.0N — AVERAGE LONGITUDE 147.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	-05.6	(05 15)	02.3	04.3	(15 21)	248	31
SEA TEMP (DEG C)	03.3	(31 15)	03.4	05.0	(18 00)	248	31
AIR-SEA TEMP (DEG C)	-07.1	(05 15)	-01.1	00.9	(15 21)	248	31
PRESSURE (MBAR)	0984.1	(11 03)	1007.0	1030.2	(29 00)	248	31

WIND — % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N			3.3	4.1	.4	.8	8.5	15.0
NE				.8			.8	20.5
E				.8	.8		1.6	19.5
SE			.4	2.0	1.2		3.7	18.5
S			.8	4.5	2.8		8.1	17.8
SW			1.2	14.2	10.6	.8	26.8	20.3
W		.4	5.3	13.4	16.7	2.4	38.2	21.4
NW			1.6	4.1	4.5	2.8	13.8	25.5
CALM		.4					.4	.0
TOTAL		.8	10.6	43.9	37.0	6.9	100.0	20.6

MAX WIND: SPEED: 53 KNOTS; DIRECTION: 320 DEG; DAY: 15; HOUR: 09

NO. OF OBS: 246

WAVES — % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 247

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY		12.1	25.9	32.0	21.8	6.9	1.2		3.4M	8.5M (11 12)

% OF OBS WITH POTENTIAL SUPERSTRUCTURE ICING: MODERATE: 1.2% SEVERE: NONE

APRIL — DATA SUMMARY — EB03
AVERAGE LATITUDE 56.0N — AVERAGE LONGITUDE 147.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	-03.5	(14 12)	02.8	05.1	(24 05)	238	30
SEA TEMP (DEG C)	03.5	(18 15)	03.6	04.8	(26 03)	238	30
AIR-SEA TEMP (DEG C)	-06.7	(14 12)	-00.8	01.6	(02 00)	237	30
PRESSURE (MBAR)	0978.5	(15 03)	1007.8	1025.4	(01 00)	239	30

WIND — % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		.8	1.3	4.7	5.8	.8	12.4	21.9
NE		.4	.4	7.6			4.7	14.1
E			.4	3.4	.4		4.3	14.6
SE		.4	.8	5.0	3.0	.4	10.5	18.9
S			3.8	9.4	8.5	1.3	23.1	18.5
SW			1.3	8.5	3.8		15.7	18.3
W		1.3	3.4	7.1	2.6	.4	15.4	15.0
NW		.4	2.6	6.8	5.1	1.3	16.2	19.0
CALM		.8					.8	.0
TOTAL		3.4	14.1	50.0	27.4	4.9	100.0	18.3

MAX WIND: SPEED: 51 KNOTS; DIRECTION: 350 DEG; DAY: 15; HOUR: 06

NO. OF OBS: 234

WAVES — % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 233

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY		27.0	38.2	17.2	13.7	3.0	.9		2.0M	8.0M (04 18)

% OF OBS WITH POTENTIAL SUPERSTRUCTURE ICING: MODERATE: 2.1% SEVERE: NONE

MARCH — DATA SUMMARY — EB15
AVERAGE LATITUDE 32.3N — AVERAGE LONGITUDE 079.5W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	17.3	(28 18)	19.9	21.4	(31 21)	25	4
SEA TEMP (DEG C)	18.9	(30 03)	20.2	20.4	(31 21)	25	4
AIR-SEA TEMP (DEG C)	-02.7	(28 18)	-00.7	00.9	(31 21)	25	4
PRESSURE (MBAR)	1019.7	(31 21)	1020.7	1023.2	(29 15)	25	4

WIND — % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N								
NE								
E								
SE								
S				53.8			53.8	16.1
SW				38.5	7.7		46.2	18.3
W								
NW								
CALM								
TOTAL				92.3	7.7		100.0	17.1

MAX WIND: SPEED: 23 KNOTS; DIRECTION: 240 DEG; DAY: 31; HOUR: 09

NO. OF OBS: 25

WAVES — % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 25

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY		100.0							1.4M	1.9M (31 21)

APRIL — DATA SUMMARY — EB15
AVERAGE LATITUDE 32.5N — AVERAGE LONGITUDE 079.3W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	16.4	(10 18)	18.8	24.1	(15 18)	240	30
SEA TEMP (DEG C)	20.7	(01 00)	22.7	24.4	(09 21)	240	30
AIR-SEA TEMP (DEG C)	-07.8	(10 18)	-03.8	01.8	(04 03)	240	30
PRESSURE (MBAR)	1006.1	(26 00)	1020.5	1032.8	(11 15)	240	30

WIND — % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N			1.7	.8			2.5	8.8
NE		.4	2.9	5.4	1.3		10.0	13.1
E		.8	4.6	4.6	1.3		11.3	12.6
SE		.4	.4	2.9	1.3		5.0	13.0
S		.8	8.3	5.8	7.5		22.5	16.2
SW		.8	3.8	6.3	5.8		16.7	16.8
W		.8	5.8	10.0	1.7		18.3	15.8
NW			.4	3.3	1.3		5.0	17.8
CALM		.8					.8	.0
TOTAL		5.0	30.8	45.0	18.8		100.0	14.2

MAX WIND: SPEED: 33 KNOTS; DIRECTION: 230 DEG; DAY: 06; HOUR: 18

NO. OF OBS: 240

WAVES — % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 240

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY		11.7	71.7	13.9	2.9	.4			1.5M	4.2M (06 00)

MARCH — DATA SUMMARY — EB16
AVERAGE LATITUDE 42.5N — AVERAGE LONGITUDE 130.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	08.2	(01 09)	10.5	11.8	(02 15)	17	3
SEA TEMP (DEG C)	10.6	(03 03)	11.1	11.4	(01 00)	18	3
AIR-SEA TEMP (DEG C)	-02.2	(01 09)	-00.6	01.2	(02 15)	17	3
PRESSURE (MBAR)	1005.4	(07 15)	1022.7	1034.8	(10 18)	246	31

WIND — % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		.4	3.7	8.9	12.6		25.6	20.2
NE		.4	.4	.4	.4		1.6	11.3
E								
SE			.4				.4	7.0
S				1.2	1.2		2.4	20.0
SW		.4	2.8	7.3	4.5		15.0	17.4
W			5.3	9.8	7.7		22.8	18.5
NW			3.3	16.5	12.6		32.1	19.8
CALM								
TOTAL		1.2	15.8	43.8	39.0		100.0	19.1

MAX WIND: SPEED: 33 KNOTS; DIRECTION: 280 DEG; DAY: 12; HOUR: 00

NO. OF OBS: 240

WAVES — % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 247

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY		8.1	18.0	32.8	28.3	11.7			2.7M	7.5M (09 09)

APRIL — DATA SUMMARY — EB16
AVERAGE LATITUDE 42.5N — AVERAGE LONGITUDE 130.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
PRESSURE (MBAR)	1000.8	(22 00)	1020.5	1034.6	(17 21)	236	30

WIND — % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N			1.3	10.1	4.6		16.0	17.5
NE			1.7	3.8			5.5	10.7
E		.6	2.5	1.3			4.2	9.3
SE			2.5	10.5	1.3		14.3	13.9
S		.4	2.5	13.5	2.1		18.5	15.0
SW			4.2	10.1			14.3	13.0
W			5.1	6.6	.8		12.7	13.3
NW			3.4	8.0	2.1		13.5	15.5
CALM		.8					.8	.0
TOTAL		1.7	25.2	64.1	11.0		100.0	14.2

MAX WIND: SPEED: 51 KNOTS; DIRECTION: 180 DEG; DAY: 22; HOUR: 00

NO. OF OBS: 237

WAVES — % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 235

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY		38.2	36.6	20.9	4.4				2.3M	5.0M (16 21)

MARCH — D A T A S U M M A R Y — EB17

AVERAGE LATITUDE 52.0N — AVERAGE LONGITUDE 156.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	-04.3	(10 23)	01.9	04.7	(31 21)	248	31
SEA TEMP (DEG C)	02.6	(23 18)	02.9	03.0	(04 03)	247	31
AIR-SEA TEMP (DEG C)	-07.0	(10 23)	-01.0	01.9	(31 21)	247	31
PRESSURE (MBAR)	0989.2	(06 21)	1012.6	1033.6	(14 06)	248	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		1.2	1.2	.8			3.2	19.3
NE		.8	1.6				2.4	15.7
E		.8	1.6	.8			3.2	20.0
SE	.4		1.6	2.4	.4		4.8	21.8
S		1.6	8.9	8.9	.4		19.8	20.8
SW		1.6	14.1	11.3	2.4	.8	30.2	22.4
W	.4	1.2	6.5	15.3	2.4	.4	26.2	24.3
NW		.8	3.6	5.3	2.4		12.1	24.5
CALM							.0	
TOTAL	.8	8.1	39.1	42.7	8.1	1.2	100.0	22.2

MAX WIND: SPEED: 53 KNOTS; DIRECTION: 240 DEG; DAY: 02; HOUR: 12

NO. OF OBS: 248

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 248

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY		4.0	30.2	21.8	33.1	6.9	2.4		1.7M	9.0M (02 15)

% OF OBS WITH POTENTIAL SUPERSTRUCTURE ICING — MODERATE: 5.6% SEVERE: NONE — OBS: 248

APRIL — D A T A S U M M A R Y — EB17

AVERAGE LATITUDE 52.0N — AVERAGE LONGITUDE 156.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	-04.4	(14 19)	01.8	05.3	(02 00)	239	30
SEA TEMP (DEG C)	02.6	(05 19)	02.9	03.4	(02 00)	239	30
AIR-SEA TEMP (DEG C)	-07.2	(14 19)	-01.1	02.4	(02 00)	239	30
PRESSURE (MBAR)	0992.8	(04 06)	1010.6	1029.1	(26 21)	239	30

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		1.7	7.1	5.0			13.8	18.8
NE	.4	.8	2.1				3.3	11.6
E		.4					.4	7.1
SE		.4	.4				.8	8.5
S		2.1	8.8	5.9			18.7	19.0
SW	.8	2.1	13.4	5.8			22.2	17.5
W	.4	1.3	8.4	12.1	.4		22.6	21.7
NW	.4	2.5	8.4	7.8			19.2	19.7
CALM	.8						.8	.0
TOTAL	2.9	11.3	48.5	36.8	.4		100.0	18.8

MAX WIND: SPEED: 39 KNOTS; DIRECTION: 280 DEG; DAY: 04; HOUR: 08

NO. OF OBS: 239

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 239

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY		20.1	42.3	23.8	13.8				1.2M	5.5M (20 06)

% OF OBS WITH POTENTIAL SUPERSTRUCTURE ICING — MODERATE: 4.2% SEVERE: NONE — OBS: 239

MARCH — D A T A S U M M A R Y — EB19

AVERAGE LATITUDE 51.0N — AVERAGE LONGITUDE 136.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
PRESSURE (MBAR)	0977.2	(06 21)	1013.9	1039.0	(29 18)	248	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		3.3	3.3	2.0	.4		9.0	16.0
NE		.8		.4			1.2	13.7
E	.4		1.6	.4			2.4	14.5
SE			.4	.4			.8	17.0
S		1.6	1.6	3.7	2.0		8.9	24.9
SW	.8	1.2	9.8	5.3	.4		17.5	18.7
W	.8	1.2	15.4	14.6	2.4		34.5	21.8
NW			8.5	14.2	2.0		24.7	24.1
CALM	.4						.4	.0
TOTAL	2.4	8.5	40.7	41.1	7.3		100.0	21.1

MAX WIND: SPEED: 46 KNOTS; DIRECTION: 180 DEG; DAY: 10; HOUR: 21

NO. OF OBS: 248

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 241

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY		9.5	27.0	16.7	29.5	12.9	2.9		1.8M	8.5M (11 15)

APRIL — D A T A S U M M A R Y — EB19

AVERAGE LATITUDE 51.0N — AVERAGE LONGITUDE 136.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
PRESSURE (MBAR)	0984.2	(21 18)	1016.8	1038.1	(02 21)	238	30

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	1.3	2.9	.4				4.6	5.8
NE		2.1	.8				3.0	10.8
E	.8	2.5	1.7	4.2			9.2	18.7
SE	.4	5.0	5.0	1.3	.4		12.1	13.4
S		4.2	7.5	5.4	.8		18.0	18.3
SW		2.9	8.4	4.6	1.3		17.2	18.3
W		4	10.5	7.5			23.0	19.8
NW	.8	3.8	3.8	1.3			9.6	12.8
CALM	.4						.4	.0
TOTAL	3.8	23.8	46.2	24.7	2.5		100.0	15.6

MAX WIND: SPEED: 41 KNOTS; DIRECTION: 180 DEG; DAY: 14; HOUR: 09

NO. OF OBS: 239

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 231

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY	3.0	33.3	31.2	19.9	10.0	2.2	.4		1.2M	8.0M (16 00)

MARCH — D A T A S U M M A R Y — EB34

AVERAGE LATITUDE 40.1N — AVERAGE LONGITUDE 073.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	07.2	(30 15)	09.1	10.2	(31 18)	11	2
SEA TEMP (DEG C)	09.2	(30 19)	09.6	10.1	(31 15)	11	2
AIR-SEA TEMP (DEG C)	-01.8	(30 15)	-00.6	04.8	(31 18)	11	2
PRESSURE (MBAR)	1001.5	(31 15)	1008.5	1013.8	(30 15)	11	2

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N								
NE								
E								
SE								
S			9.1	45.5			54.5	13.2
SW				45.5			45.5	16.0
W								
NW								
CALM								
TOTAL			9.1	90.9			100.0	14.5

MAX WIND: SPEED: 19 KNOTS; DIRECTION: 240 DEG; DAY: 31; HOUR: 21

NO. OF OBS: 11

APRIL — D A T A S U M M A R Y — EB34

AVERAGE LATITUDE 40.1N — AVERAGE LONGITUDE 073.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	-01.5	(09 15)	07.8	12.8	(24 00)	235	30
SEA TEMP (DEG C)	09.2	(04 09)	08.8	10.2	(21 21)	235	30
AIR-SEA TEMP (DEG C)	-08.1	(04 09)	-01.1	05.7	(15 03)	235	30
PRESSURE (MBAR)	0988.5	(09 21)	1017.2	1031.3	(09 19)	234	30

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		.8	2.1	1.3			4.3	7.3
NE			.8	.4			1.3	11.7
E		1.3	7.3	9.0	.4		18.0	16.6
SE		2.1	4.3	5.0			11.4	14.5
S		1.7	8.0	9.0	.4		19.1	16.8
SW		1.7	7.7	15.8	.4		25.6	18.0
W		.4	7.3	8.8	1.7		18.2	19.0
NW		.4	5.1	5.8			11.1	18.0
CALM								
TOTAL		8.5	40.8	47.8	3.0		100.0	17.0

MAX WIND: SPEED: 25 KNOTS; DIRECTION: 290 DEG; DAY: 04; HOUR: 15

NO. OF OBS: 234

MARCH — D A T A S U M M A R Y — EB41

AVERAGE LATITUDE 38.7N — AVERAGE LONGITUDE 073.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	-00.5	(02 15)	07.9	13.7	(13 18)	239	31
SEA TEMP (DEG C)	05.7	(05 12)	07.5	10.8	(11 21)	238	31
AIR-SEA TEMP (DEG C)	-07.1	(02 15)	-00.2	08.3	(05 03)	239	31
PRESSURE (MBAR)	0988.7	(07 21)	1015.9	1030.6	(03 15)	239	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.9	1.9	2.8				4.1	9.8
NE	.9		1.9				2.8	9.5
E		3.8	1.0				4.3	8.8
SE	1.0	7.1	8.5	1.5			18.2	11.4
S	.5	7.6	10.2	1.5			19.8	11.9
SW	1.0	4.1	10.2	2.0	.5		17.8	14.3
W		3.8	10.2	9.1	1.0	1.0	25.0	16.2
NW		1.9	8.1	4.8			14.7	17.9
CALM								
TOTAL	3.8	28.9	50.3	14.7	1.0	1.5	100.0	14.4

MAX WIND: SPEED: 53 KNOTS; DIRECTION: 240 DEG; DAY: 23; HOUR: 03

NO. OF OBS: 187

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 223

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY	30.0	48.8	16.6	4.4	1.3				1.3M	4.0M (23 12)

APRIL — D A T A S U M M A R Y — EB41

AVERAGE LATITUDE 38.7N — AVERAGE LONGITUDE 073.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	-01.0	(08 15)	06.8	12.7	(05 15)	63	9
SEA TEMP (DEG C)	08.1	(09 12)	08.8	09.6	(11 21)	63	9
AIR-SEA TEMP (DEG C)	-08.8	(09 15)	00.2	05.8	(05 15)	63	9
PRESSURE (MBAR)	0982.4	(05 21)	1018.8	1032.1	(08 15)	63	9

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N			9.5				9.5	16.0
NE		3.2	1.6				4.8	9.5
E			7.9				7.9	17.2
SE		6.3	3.2				9.5	8.8
S		1.6	14.2	1.6			17.5	17.1
SW		9.5	9.5				19.0	10.8
W		3.2	14.3				17.5	13.2
NW		9.5	4.8	1.6			14.3	16.2
CALM								
TOTAL		37.0	69.8	3.2			100.0	13.8

MAX WIND: SPEED: 24 KNOTS; DIRECTION: 300 DEG; DAY: 07; HOUR: 03

NO. OF OBS: 63

MARCH — D A T A S U M M A R Y — EB43

AVERAGE LATITUDE 58.8N — AVERAGE LONGITUDE 148.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	-01.1	(08 08)	02.7	09.6	(15 00)	214	31
SEA TEMP (DEG C)	04.7	(02 18)	06.0	08.7	(15 00)	243	31
AIR-SEA TEMP (DEG C)	-07.8	(08 08)	-03.3	-00.7	(15 00)	213	31
PRESSURE (MBAR)	0978.0	(11 09)	1004.8	1027.4	(29 09)	211	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	1.4	.5					1.9	3.0
NE		.9		.5			1.4	8.8
E		.9	15.2	27.0	12.8	.5	56.4	19.8
SE	2.4	3.8	2.4				8.6	7.5
S		1.9	3.8	.5			6.2	9.8
SW	1.4	.9	.9				3.3	7.1
W		7.1	7.6				14.7	10.3
NW	.5	3.3	1.4				5.2	7.5
CALM	.5						.5	.0
TOTAL	5.0	23.6	49.1	13.7	.5		100.0	12.8

MAX WIND: SPEED: 34 KNOTS; DIRECTION: 070 DEG; DAY: 11; HOUR: 08

NO. OF OBS: 211

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 202

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY		34.2	33.7	18.8	10.4	3.0			1.2M	7.0M (11 18)

APRIL — D A T A S U M M A R Y — EB43

AVERAGE LATITUDE 58.8N — AVERAGE LONGITUDE 148.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	-01.1	(13 18)	04.0	08.1	(25 03)	191	30
SEA TEMP (DEG C)	06.0	(28 03)	06.1	08.1	(28 03)	193	30
AIR-SEA TEMP (DEG C)	-06.8	(13 18)	-02.2	01.2	(23 15)	188	30
PRESSURE (MBAR)	0981.0	(12 15)	1012.4	1029.0	(01 06)	193	30

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		.5	2.1				2.6	9.8
NE		.5	1.1	.5			2.1	7.5
E		.9	7.4	35.8	18.5		62.6	17.7
SE	1.1	3.7	3.2				7.9	8.4
S		2.1	2.1				4.2	10.3
SW	2.1	1.6	1.1				4.7	8.7
W	1.1	5.8	5.3				12.1	9.5
NW	2.6	1.1					3.7	5.3
CALM								
TOTAL	7.0	24.7	47.9	36.9			100.0	14.0

MAX WIND: SPEED: 32 KNOTS; DIRECTION: 070 DEG; DAY: 10; HOUR: 00

NO. OF OBS: 191

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 191

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY	3.0	41.4	22.7	23.0	7.7	.5			1.2M	6.0M (09 06)

MARCH — DATA SUMMARY — E681

AVERAGE LATITUDE 28.5N — AVERAGE LONGITUDE 090.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	10.7	(20 12)	20.8	23.2	(31 21)	62	6
PRESSURE (MBAR)	1008.2	(29 09)	1014.5	1030.9	(31 15)	97	9

WIND - M FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL	MEAN SPEED (KNOTS)
<4						
10						
21						
33						
47						
>47						
N						
NE	1.7	1.7			3.4	3.9
E	1.7	5.4	30.5	9.1	46.7	15.5
SE		3.4	15.8	9.5	28.4	17.2
S		1.7	18.8	10.2	28.8	18.5
SW						
W						
NW		1.7			1.7	7.0
CALM						
TOTAL	3.4	11.9	81.0	23.7	100.0	16.3

NO. OF OBS: 59

MAX WIND
SPEED: 30 KNOTS
DIRECTION: 170 DEG
DAY: 28
HOUR: 08

APRIL — DATA SUMMARY — E681

AVERAGE LATITUDE 29.5N — AVERAGE LONGITUDE 090.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	14.4	(05 18)	21.9	25.8	(17 21)	224	30

WIND - M FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL	MEAN SPEED (KNOTS)
<4						
10						
21						
33						
47						
>47						
N	.4	5.8	6.7	.9	13.8	12.6
NE	1.3	3.1	.8		5.4	7.3
E	.4	3.1	18.8	1.3	23.7	14.6
SE		3.6	5.4	1.8	10.5	12.7
S	.4	6.3	7.1	8.5	.4	22.0
SW		.4	.4			.9
W	.8		.9			2.7
NW	.4	5.8	5.3		.8	13.4
CALM	.9					.9
TOTAL	9.8	30.8	49.8	10.8	1.9	100.0

NO. OF OBS: 224

MAX WIND
SPEED: 41 KNOTS
DIRECTION: 330 DEG
DAY: 08
HOUR: 06

MARCH — DATA SUMMARY — E683

AVERAGE LATITUDE 40.0N — AVERAGE LONGITUDE 088.5W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	-01.1	(02 15)	04.8	08.4	(28 18)	256	30
SEA TEMP (DEG C)	03.8	(02 00)	04.8	05.6	(30 21)	234	30
AIR-SEA TEMP (DEG C)	-06.3	(02 15)	00.2	04.5	(14 12)	234	30
PRESSURE (MBAR)	0990.8	(23 15)	1013.2	1031.5	(13 12)	256	30

WIND - M FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL	MEAN SPEED (KNOTS)
<4						
10						
21						
33						
47						
>47						
N	3.8	5.1	9.0		17.9	10.5
NE		1.3			1.3	4.0
E	1.3				1.3	2.0
SE			2.6	3.8	6.4	11.8
S	1.3	2.6	1.9		5.7	7.8
SW	2.6	6.4			9.0	6.7
W	1.3	15.4	16.7		33.3	10.7
NW	3.8	11.5	10.3		25.6	10.2
CALM						
TOTAL	14.1	44.9	41.0		100.0	9.7

NO. OF OBS: 78

MAX WIND
SPEED: 18 KNOTS
DIRECTION: 340 DEG
DAY: 04
HOUR: 09

APRIL — DATA SUMMARY — E683

AVERAGE LATITUDE 40.0N — AVERAGE LONGITUDE 088.5W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	00.0	(08 21)	08.7	12.0	(08 00)	225	30
SEA TEMP (DEG C)	05.1	(02 03)	06.0	07.2	(30 21)	206	30
AIR-SEA TEMP (DEG C)	-05.6	(08 21)	00.8	08.4	(06 00)	224	30
PRESSURE (MBAR)	0984.7	(06 00)	1017.5	1034.0	(11 15)	238	30

WIND - M FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL	MEAN SPEED (KNOTS)
<4						
10						
21						
33						
47						
>47						
N			3.3		3.3	15.3
NE	1.1	2.2	1.1		4.4	7.3
E		2.2			2.2	5.0
SE		2.2			2.2	8.0
S	1.1	5.7	1.1		8.0	7.2
SW	2.2	23.3	12.2		37.8	8.7
W		16.7	10.0		26.7	8.6
NW	1.1	5.6	7.8		14.4	11.2
CALM						
TOTAL	5.5	58.0	35.6		100.0	9.5

NO. OF OBS: 93

MAX WIND
SPEED: 20 KNOTS
DIRECTION: 340 DEG
DAY: 28
HOUR: 06

MARCH — DATA SUMMARY — E870

AVERAGE LATITUDE 99.5N — AVERAGE LONGITUDE 142.3W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	-00.9	(06 05)	03.1	06.3	(05 21)	237	31
SEA TEMP (DEG C)	06.7	(30 21)	06.9	08.7	(02 18)	257	31
AIR-SEA TEMP (DEG C)	-07.5	(06 05)	-03.2	-01.0	(31 03)	236	31
PRESSURE (MBAR)	0978.0	(11 08)	1004.4	1026.5	(28 09)	238	31

WIND - M FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL	MEAN SPEED (KNOTS)
<4						
10						
21						
33						
47						
>47						
N	.8	.8	.8		2.5	7.7
NE	.4	.8	2.5	.4	4.2	12.1
E	.4	5.1	10.6	11.4	3.8	30.5
SE	.4	1.7	6.8	1.3		10.2
S	1.3	5.0	5.9	5.0		15.1
SW		3.0	3.0	1.5		8.1
W	.8	4.2	18.2	1.3		24.6
NW	2.1	1.7	3.0			8.6
CALM						
TOTAL	8.4	20.3	51.7	18.8	3.0	100.0

NO. OF OBS: 336

MAX WIND
SPEED: 45 KNOTS
DIRECTION: 080 DEG
DAY: 11
HOUR: 02

WAVES - M FREQUENCIES, MEAN AND EXTREME (METERS)

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
M FREQUENCY		27.0	40.0	13.0	14.4	5.1	.5		2.7M	6.0M (11 18)

NO. OF WAVE OBS: 319

APRIL — DATA SUMMARY — E870

AVERAGE LATITUDE 99.5N — AVERAGE LONGITUDE 142.5W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	-01.5	(13 15)	04.4	08.5	(25 18)	314	30
SEA TEMP (DEG C)	06.8	(01 06)	08.1	07.8	(23 00)	314	30
AIR-SEA TEMP (DEG C)	-07.8	(13 15)	-01.8	01.8	(23 18)	313	30
PRESSURE (MBAR)	0978.0	(13 15)	1010.8	1024.1	(01 09)	315	30

WIND - M FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL	MEAN SPEED (KNOTS)
<4						
10						
21						
33						
47						
>47						
N		1.4			1.4	6.3
NE		4.3	1.4	1.4	7.1	12.0
E		4.3	12.3	13.5	.9	31.0
SE		6.8	8.0	9.7		24.5
S	1.4	3.5	5.2	.8		10.9
SW	.5	2.4	3.8	1.0		11.4
W		4.3	7.1	.9		12.3
NW	2.4	2.4				4.7
CALM						
TOTAL	4.3	29.4	37.8	28.0	.5	100.0

NO. OF OBS: 211

MAX WIND
SPEED: 37 KNOTS
DIRECTION: 070 DEG
DAY: 18
HOUR: 03

WAVES - M FREQUENCIES, MEAN AND EXTREME (METERS)

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
M FREQUENCY	2.4	43.5	18.4	18.8	10.6	5.3			2.4M	7.0M (09 08)

NO. OF WAVE OBS: 170

MARCH — DATA SUMMARY — E871

AVERAGE LATITUDE 28.0N — AVERAGE LONGITUDE 093.5W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	18.0	(08 06)	20.5	23.8	(19 21)	248	31
SEA TEMP (DEG C)	19.7	(25 15)	21.2	23.5	(02 21)	248	31
AIR-SEA TEMP (DEG C)	-04.0	(09 09)	-00.7	02.2	(27 21)	248	31
PRESSURE (MBAR)	1005.6	(04 00)	1013.8	1028.6	(08 15)	248	31

WIND - M FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL	MEAN SPEED (KNOTS)
<4						
10						
21						
33						
47						
>47						
N		1.6	5.6	5.2	12.5	19.1
NE	1.6	7.3	13.7	.4	23.0	12.4
E	1.6	14.5	7.8	.4	24.2	9.1
SE	2.0	8.5	20.2	9.8	34.5	14.8
S		2.8	1.6		4.4	10.9
SW						
W	.4	.4			.8	3.5
NW			.8	.4	1.2	17.3
CALM						
TOTAL	5.6	33.5	48.8	12.1	100.0	13.2

NO. OF OBS: 248

MAX WIND
SPEED: 37 KNOTS
DIRECTION: 350 DEG
DAY: 04
HOUR: 12

WAVES - M FREQUENCIES, MEAN AND EXTREME (METERS)

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
M FREQUENCY	8.5	58.5	27.2	5.7					1.5M	3.0M (28 18)

NO. OF WAVE OBS: 246

APRIL — DATA SUMMARY — E871

AVERAGE LATITUDE 28.0N — AVERAGE LONGITUDE 093.5W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	19.8	(06 06)	22.0	24.1	(16 06)	225	30
SEA TEMP (DEG C)	20.6	(08 12)	22.5	23.6	(06 21)	225	30
AIR-SEA TEMP (DEG C)	03.5	(17 00)	-00.6	01.5	(02 15)	225	30
PRESSURE (MBAR)	1001.8	(04 09)	1017.7	1032.0	(07 15)	225	30

WIND - M FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL	MEAN SPEED (KNOTS)
<4						
10						
21						
33						
47						
>47						
N		2.2	4.4	.4	7.1	13.5
NE		4.0	6.2		10.2	11.6
E		9.9	39.2	.4	48.0	13.3
SE		2.2	18.7	.4	21.3	15.4
S		.4	1.3		1.8	14.5
SW						
W		.9	.4		1.3	10.4
NW		.9	8.7	2.7	10.2	17.2
CALM						
TOTAL		20.0	78.0	4.0	100.0	14.0

NO. OF OBS: 225

MAX WIND
SPEED: 28 KNOTS
DIRECTION: 310 DEG
DAY: 17
HOUR: 00

WAVES - M FREQUENCIES, MEAN AND EXTREME (METERS)

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
M FREQUENCY	12.7	77.7	7.6	2.0					1.2M	3.0M (05 09)

NO. OF WAVE OBS: 197

MARCH — DATA SUMMARY — E804

AVERAGE LATITUDE 26.0N — AVERAGE LONGITUDE 088.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	17.0	(01 09)	22.5	27.5	(15 21)	185	31
DEWPOINT TEMP (DEG C)	04.7	(01 09)	19.1	23.5	(15 12)	184	31
PRESSURE (MBAR)	1006.0	(10 09)	1019.0	1036.6	(01 03)	185	31

WIND - M FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL	MEAN SPEED (KNOTS)
<4						
10						
21						
33						
47						
>47						
N	.6	1.2	4.8	4.8	10.8	16.7
NE	3.0	3.4	9.7		15.2	10.8
E	.6	7.3	4.8		12.7	10.9
SE	1.8	12.1	14.5	8.1	34.5	13.8
S	.6	7.8	14.5	1.8	24.2	13.3
SW		1.2			1.2	7.0
W		.6			.6	10.0
NW	.6				.6	1.0
CALM						
TOTAL	7.3	32.7	48.5	11.5	100.0	12.9

NO. OF OBS: 165

MAX WIND
SPEED: 27 KNOTS
DIRECTION: 140 DEG
DAY: 12
HOUR: 06

WAVES - M FREQUENCIES, MEAN AND EXTREME (METERS)

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
M FREQUENCY	16.3	58.5	18.8	6.1					1.4M	3.5M (04 12)

NO. OF WAVE OBS: 147

APRIL — DATA SUMMARY — E804

AVERAGE LATITUDE 41.0N — AVERAGE LONGITUDE 137.5W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	07.8	(19 21)	10.4	12.7	(12 12)	151	19
PRESSURE (MBAR)	0997.4	(22 12)	1017.4	1038.0	(10 06)	151	19

WIND - M FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL	MEAN SPEED (KNOTS)
<4						
10						
21						
33						
47						
>47						
N		2.6	11.3		13.9	15.2
NE	2.0	1.3			3.3	4.6
E		4.6	.7		5.3	7.6
SE		2.0	4.0	.7	6.6	14.7
S		2.0	9.3	1.3	12.6	15.6
SW		5.3	19.8	7.3	32.5	15.8
W	.7	2.6	10.6	3.3	17.2	15.5
NW	1.3	5.3	9.3	.7	15.8	12.9
CALM						
TOTAL	4.0	25.8	67.8	12.6	100.0	14.6

NO. OF OBS: 191

MAX WIND
SPEED: 29 KNOTS
DIRECTION: 180 DEG
DAY: 20
HOUR: 00

WAVES - M FREQUENCIES, MEAN AND EXTREME (METERS)

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
M FREQUENCY		28.5	46.3	22.5	3.3				2.5M	4.5M (15 09)

NO. OF WAVE OBS: 151

Table 5

Selected Gale and Wave Observations, North Atlantic

March and April 1977

Vessel	Nationality	Date	Position of Ship		Time GMT	Wind		Visibility n. mi.	Present Weather code	Pressure mb.	Temperature °C		Sea Waves†		Swell Waves		
			Lat. deg.	Long. deg.		Dir. 10°	Speed kt.				Air	Sea	Period sec.	Height ft.	Dir. 10°	Period sec.	Height ft.
NORTH ATLANTIC OCEAN		MAR.															
SEALAND PRODUCER	AMERICAN	1	45.3 N	55.7 W	06	20	45	2 NM	10	999.0	2.2	5.5	5	5			
SEALAND MARKET	AMERICAN	2	40.9 N	62.7 W	12	20	42	10 NM	03	1011.5	9.5	11.7	2	3	24	10	21
SANTA MERCEDES	AMERICAN	5	11.2 N	74.9 W	06	06 M	30	5 NM	07	1004.4	24.4	24.4	5	8	06	7	13
EXXON CHESTER	AMERICAN	5	37.2 N	72.1 W	06	18	50	5 NM	02	1013.5	20.0	17.5	5	10			
FROSTFJORD	NORWEGIAN	5	36.7 N	40.4 W	12	32 M	45	10 NM	60	1015.0	13.0						
EXPORT DEMOCRACY	AMERICAN	7	38.8 N	37.6 W	06	27	50	5 NM	25	996.3	15.0	15.0	4	10	27	6	24.5
SEALAND ECONOMY	AMERICAN	8	40.8 N	21.6 W	06	18	41	2 NM	60	999.0	12.2	13.4	5	11.5	19	6	14.5
EXPORT DEMOCRACY	AMERICAN	8	39.0 N	47.5 W	21	25	60	2 NM	20	993.2	16.1	17.2	4	10	25	6	24.5
SEALAND GALLOWAY	AMERICAN	9	42.7 N	40.2 W	06	21	65	200 YD	82	983.5	13.4	14.0	14	49			
SEALAND MARKET	AMERICAN	9	43.0 N	32.6 W	09	18	60	2 NM	82	980.5	15.0	12.8	10	24.5			
TRANSCOLUMBIA	AMERICAN	9	45.4 N	29.1 W	18	23	55	1 NM	18	968.5	12.8	14.0	3	10	23	7	28
MEONIA	DANISH	9	40.6 N	32.9 W	18	26	48	2 NM	02	1006.0	14.6		11	32.5			
EXPORT DEMOCRACY	AMERICAN	9	39.0 N	47.6 W	00	27	55	5 NM	21	1002.1	11.2	17.2	4	10	27	6	24.5
ADM W M CALLAGHAN	AMERICAN	9	48.2 N	30.5 W	17	35	58	1 NM	62	985.1	10.0	10.0	5	6.5	25	7	6.5
Z.IM. TOKYO	GERMAN	9	38.0 N	39.9 W	12	29	52	5 NM	01	1014.0	13.0	17.2		10	29	X	19.5
ADM W M CALLAGHAN	AMERICAN	10	46.6 N	38.4 W	18	28	55	5 NM	83	1014.9	6.2	10.0	5	10	31	9	19.5
AMER LEGACY	AMERICAN	10	50.6 N	19.6 W	12	27	43	1 NM	25	972.0	9.5		5	10	28	9	19.5
SEALAND MARKET	AMERICAN	10	45.6 N	21.8 W	00	26	54	5 NM	07	981.0	12.8	10.7	12	41			
AMER LEGACY	AMERICAN	12	47.7 N	36.5 W	12	27	55	2 NM	26	994.8	3.9	12.2	4	14.5	28	9	32.5
AMER LEGACY	AMERICAN	13	47.3 N	39.0 W	00	32	50	5 NM	01	1004.0	3.3	12.2	4	14.5	30	7	31
LEON	HONDURAN	13	46.3 N	13.6 W	18	23	50	10 NM	60	1008.5	10.0	12.3	5	19.5	25	< 6	32.5
LEON	HONDURAN	14	46.1 N	13.8 W	00	23	45	10 NM	02	1011.2	10.0	12.3	5	16.5	25	< 6	29.5
SEALAND CONSUMER	AMERICAN	15	48.7 N	12.3 W	12	22	40	10 NM	01	1000.0	12.8	11.2	6	10	22	8	32.5
LEON	HONDURAN	15	44.1 N	17.9 W	06	23	50	10 NM	02	1002.4	12.5	13.0	5	16.5	25	< 6	32.5
HOEGH TRIGGER	NORWEGIAN	15	47.6 N	14.8 W	18	23 M	41	5 NM	18	998.0	10.0	12.0	8	23			
LEON	HONDURAN	16	43.2 N	19.1 W	00	23	50	10 NM	02	1006.7	12.5	13.0	5	14.5	25	< 6	32.5
Z.IM HONGKONG	LIBERIAN	19	30.8 N	74.0 W	18	31	45	2 NM	60	998.5	7.2		8	10	32	12	13
AMER ARCHER	AMERICAN	19	42.8 N	58.4 W	18	27	48	1 NM	07	985.5	11.2	13.4	2	16.5	27	>13	49
EXPORT PATRIOT	AMERICAN	19	44.4 N	58.3 W	18	21	50	2 NM	02	973.6	2.2	2.2	3	13	21	8	26
EXPORT PATRIOT	AMERICAN	20	44.5 N	60.0 W	00	28	50	10 NM	25	993.9	- 1.2	2.2	3	14.5	28	8	29.5
AMER ARCHER	AMERICAN	20	42.6 N	59.5 W	00	29	35	1 NM	07	998.2	1.7	11.2	5	16.5	29	7	32.5
HOEGH TRIGGER	NORWEGIAN	21	37.1 N	57.1 W	18	27 M	38	2 NM	60	1006.0	18.0	17.0					
BALD BUTTE	AMERICAN	22	35.1 N	74.0 W	18	23	30	5 NM	02	996.5	22.2	24.5	5	8			
AMER LEADER	AMERICAN	22	43.0 N	58.0 W	12	32	41	2 NM	23	1002.0	3.3	9.5	5	8	32	6	19.5
SEALAND MARKET	AMERICAN	22	36.0 N	52.2 W	12	29	50	10 NM	01	1011.8	15.0	14.4	2	8	31	7	24.5
SEALAND MARKET	AMERICAN	23	37.2 N	64.6 W	18	25	50	2 NM	02	999.3	20.5	15.0	3	6.5	25	10	24.5
HOEGH TRIGGER	NORWEGIAN	23	35.2 N	63.3 W	06	20 M	47	.5 NM	63	1000.0	19.5	18.0			20	7	10
BALD BUTTE	AMERICAN	23	34.3 N	74.0 W	00	31	50	5 NM	00	1000.6	16.7	23.3	5	8			
ATLANTICA LIVORNO	GERMAN	23	39.0 N	68.2 W	12	25	44	5 NM	02	992.4	12.2		7	8	23	12	13
WILMINGTON GETTY	AMERICAN	23	38.4 N	71.8 W	12	27	50	5 NM	02	999.7	5.5	10.7	6	14.5	26	12	19.5
SEALAND MARKET	AMERICAN	24	39.5 N	67.5 W	12	31	50	5 NM	68	993.9	5.0	12.2	12	19.5			
NORMACCAPE	AMERICAN	24	34.7 N	63.1 W	12	29	48	10 NM	01	1006.4	15.7	19.5			27	>13	24.5
HOEGH TRIGGER	NORWEGIAN	24	34.1 N	67.5 W	06	32 M	44	5 NM	02	1006.0	15.0	18.0	5	14.5			
DOCTOR LYKES	AMERICAN	24	40.5 N	14.3 W	06	14	45	2 NM	20	1001.2	10.5	11.1	7	16.5	14	11	19.5
MOHAWK	AMERICAN	25	26.4 N	54.3 W	00	23	41	10 NM	80	1011.9	23.3	24.4					
HOEGH TRIGGER	NORWEGIAN	25	33.1 N	68.8 W	06	32 M	49	5 NM	02	1008.0	14.0	19.0	8	19.5			
AEOLUS	AMERICAN	25	32.0 N	65.0 W	06	29 M	42	10 NM	02	1008.0	16.6	20.0	3	6.5	29	>13	10
NAI SILVANA	ITALIAN	29	34.0 N	47.3 W	18	36	47	5 NM	00	1012.0	17.0	20.0			36	6	10
MOKAMBO	BELGIAN	30	46.5 N	38.9 W	00	28	45	1 NM	82	992.0	12.0	13.0	10	10			
OCEAN STATION VESSELS																	
ATLANTIC H																	
BIBB	AMERICAN	18	38.0 N	71.0 W	21	21 M	45	5 NM	07	989.5	18.8	14.5	6	13			
BIBB	AMERICAN	19	38.0 N	71.0 W	00	21 M	50	5 NM	80	988.4	19.0	17.4	6	18			
GALLATIN	AMERICAN	22	38.0 N	71.0 W	21	16 M	48	5 NM	07	989.7	18.0	20.1	6	16.5			
GALLATIN	AMERICAN	23	38.0 N	71.0 W	06	28 M	50	5 NM	07	995.2	10.3	20.8	7	19.5			
NORTH ATLANTIC OCEAN		APR.															
SEALAND GALLOWAY	AMERICAN	5	46.0 N	30.0 W	18	16	45	2 NM	07	1010.5	11.7	11.7	10	14.5	18	10	19.5
EVERGREEN	AMERICAN	5	43.5 N	50.2 W	06	28 M	42	.5 NM	88	1001.8	0.0	1.9	8	16.5			
RESEARCHER	AMERICAN	6	38.4 N	70.0 W	00	21 M	45	2 NM	05	998.1	21.0	13.1	4	11.5	20	8	16.5
PVT JOHN R TOWLE	AMERICAN	6	34.7 N	73.3 W	00	19	48	5 NM	60	1005.8	21.6	21.2	10	13	20	10	18
LASH ATLANTICO	AMERICAN	7	28.5 N	37.6 W	18	33	41	10 NM	02	1000.0	18.9	18.3	2	5	32	< 6	14.5
TRANSEASTERN	AMERICAN	7	26.3 N	41.7 W	00	31	45	10 NM	03	1014.6	20.0	23.0	4	8	03	6	13
ATLANTIC CARRIER	LIBERIAN	8	28.7 N	33.8 W	20	36	48	2 NM	03	1002.0	20.0	20.5	6	16.5			
SEALAND ECONOMY	AMERICAN	8	35.4 N	32.2 W	06	03	46	2 NM	20	1009.0	15.0	16.2	6	16.5	07	X	23
AUSTRAL ENDURANCE	AMERICAN	12	24.3 N	81.8 W	00	05	45	200 YD	64	1020.0	19.5	25.6	4	10			
SEALAND MARKET	AMERICAN	12	38.7 N	50.4 W	18	30	45	5 NM	64	1004.5	14.4	14.4	4	8	30	7	14.5
FROSTA	NORWEGIAN	17	34.3 N	47.0 W	06	14	55	1 NM	62	1004.0	18.0	20.0	4	16.5	XX	X	29.5
OCEAN STATION VESSELS																	
ATLANTIC H																	
TANEY	AMERICAN	6	38.0 N	71.0 W	00	22 M	48	2 NM	80	997.8	21.8	20.1	6	18			

† Direction for sea waves same as wind direction
X Direction or period of waves indeterminate
M Measured wind

NOTE: The observations are selected from those with winds ≥ 35 kn or waves ≥ 25 ft from May through August (≥ 41 kn or ≥ 33 ft, September through April). In cases where a ship reported more than one observation a day with such values, the one with the highest wind speed was selected.

Table 6
Selected Gale and Wave Observations, North Pacific
March and April 1977

Vessel	Nationality	Date	Position of Ship Lat. deg.	Position of Ship Long. deg.	Time GMT	Wind Dir. 10°	Wind Speed kt.	Visibility n. mi.	Present Weather code	Pressure mb	Temperature °C Air	Temperature °C Sea	Sea Waves† Period sec.	Sea Waves† Height ft.	Swell Waves Dir. 10°	Swell Waves Period sec.	Swell Waves Height ft.
NORTH PACIFIC OCEAN		MAR.															
PRESIDENT MADISON	AMERICAN	1	43.3 N	151.7 E	06	28	60	5 NM	26	999.4	- 1.7		6	19.5			
SEPTA	LIBERIAN	1	40.9 N	160.5 E	12	27	M 47	2 NM	41	998.5		9.0	8	13			
MELLON	AMERICAN	1	52.0 N	167.8 W	18	09	M 42	200 YD	73	980.6	2.8	3.8	9	13			
VANGUARD	LIBERIAN	1	14.3 N	95.7 W	06	05	M 45	2 NM	01	1013.0	22.0	27.0					
ORIENTAL SOVERIGN	LIBERIAN	2	53.1 N	145.0 W	18	23	M 45	2 NM	80	992.8	5.5	6.0	5	19.5	27	8	24.5
VAN WARRIOR	LIBERIAN	2	52.7 N	155.5 W	18	26	65	2 NM	50	993.0	6.0	6.0					
SEALAND TRADE	AMERICAN	2	46.9 N	164.2 W	00	26	47	10 NM	01	1003.0	2.2	4.4	6	24.5			
LIONS GATE BRIDGE	JAPANESE	2	50.9 N	138.7 W	18	27	M 42	2 NM	02	1009.0	7.5	8.0			27	10	23
BEISHU MARU	JAPANESE	2	45.9 N	169.8 W	00	25	M 41	10 NM	02	1006.6	5.0	4.7	3	5	26	8	13
PEARL VENTURE	LIBERIAN	3	46.4 N	129.0 W	00	34	50	1 NM	80	1012.9	10.0	8.0	4	8	27	7	16.5
NEWARK	AMERICAN	3	55.4 N	143.6 W	00	24	30	5 NM	02	987.5	3.9	3.5	9	13	23	12	23
ORIENTAL SOVERIGN	LIBERIAN	3	53.2 N	145.9 W	00	25	M 45	2 NM	80	999.9	7.2	5.0	5	28	25	8	32.5
LIONS GATE BRIDGE	JAPANESE	3	52.0 N	142.7 W	06	23	M 43	2 NM	02	1011.0	6.5	7.0	8	26	26	10	26
BELMAR	NORWEGIAN	3	54.0 N	158.8 W	00	25	45	2 NM	62	988.0	6.0	6.0	12	19.5			
VAN WARRIOR	LIBERIAN	3	52.7 N	156.1 W	00	23	60	2 NM	50	992.0	6.0	6.0					
PRES KENNEDY	AMERICAN	3	54.1 N	146.9 W	00	25	50	2 NM	61	995.9	6.7	3.9			25	11	41
SANTA CLARA	AMERICAN	3	46.4 N	128.9 W	06	31	48	10 NM	03	1024.4	9.4	11.2	9	16.5	36	7	36
CHEVRON HAWAII	AMERICAN	4	57.5 N	146.5 W	18	24	42	10 NM	02	984.5	3.9	4.4	10	14.5			
SANTA CLARA	AMERICAN	4	46.6 N	131.3 W	00	22	18	10 NM	03	1031.2	10.0	11.1	2	5	29	11	36
PRES KENNEDY	AMERICAN	4	54.2 N	160.1 W	12	32	45	5 NM	01	999.7	2.8	2.8	7	13	32	11	13
VAN WARRIOR	LIBERIAN	4	52.0 N	159.1 W	18	32	35	10 NM	03	1011.0	4.0	4.0					
MILENA	NORWEGIAN	5	32.7 N	147.2 E	06	27	30	10 NM	80	1010.0	12.5						
PRES TAFT	AMERICAN	5	32.2 N	149.7 E	06	25	35	2 NM	18	1006.2	17.8	14.4	7	29.5			
ORIENTAL COMMANDER	LIBERIAN	5	35.8 N	154.7 E	12	23	41	10 NM	02	1005.8	13.0		NX	14.5	26	X	29.5
SEALAND EXCHANGE	AMERICAN	5	36.3 N	148.6 E	06	05	48	1 NM	60	999.0	6.0	15.6	4	6.5	06	6	13
ADRIAN MAERSK	DANISH	5	35.9 N	151.8 E	06	29	47	10 NM	15	999.5	13.0		10	23			
VAN WARRIOR	LIBERIAN	5	51.4 N	166.8 W	18	27	60	2 NM	03	998.0	5.0	4.0					
VIOLET	LIBERIAN	5	50.4 N	165.4 W	14	26	M 65	5 NM	02	977.0	5.0	3.0			25	< 6	16.5
VAN CONQUEROR	LIBERIAN	5	48.5 N	156.4 W	18	25	M 45	2 NM	51	992.0	1.0	7.0					
ATLANTIC PIONEER	PANAMANIAN	6	46.8 N	143.0 W	12	27	M 49	5 NM	02	992.0	6.0	5.0	12	18	27	13	24.5
VAN WARRIOR	LIBERIAN	6	51.5 N	167.3 W	00	27	55	5 NM	01	998.0	7.0	4.0					
VIOLET	LIBERIAN	6	50.3 N	168.7 W	00	26	M 45	2 NM	02	1002.0	4.0	5.0			27	8	32.5
VAN CONQUEROR	LIBERIAN	6	48.5 N	156.8 W	00	27	M 50	1 NM	55	997.0	1.0	6.0					
OCEAN LOG	JAPANESE	6	45.1 N	134.6 W	12	20	M 43	.25 NM		1003.0	7.0	9.0	8	13			
LONG BEACH	PANAMANIAN	6	45.4 N	140.1 W	06	24	M 54	.5 NM	07	1003.3	8.3	7.9					
MELLON	AMERICAN	7	54.1 N	166.8 W	12	25	M 42	10 NM	85	982.4	2.2	4.3	7	10			
ATLANTIC PIONEER	PANAMANIAN	7	44.7 N	144.6 W	06	27	M 50	2 NM	02	997.5	7.0	6.0	12	19.5	27	13	24.5
VAN CONQUEROR	LIBERIAN	7	48.5 N	160.6 W	00	27	M 50	2 NM	51	993.0	4.0	6.0					
PRES FILLMORE	AMERICAN	7	48.6 N	126.8 W	00	18	45	2 NM	62	998.0	8.3	8.9	5	14.5	18	10	14.5
OCEAN LOG	JAPANESE	7	44.1 N	136.1 W	00	27	M 41	.25 NM	53	1003.0	7.0	9.0	8	13			
ORIENTAL SOVERIGN	LIBERIAN	7	54.0 N	170.5 W	06	26	M 45	5 NM	02	983.5	1.5	4.5	7	24.5	26	9	32.5
SEPTA	LIBERIAN	7	45.3 N	150.7 W	12	31	M 41	10 NM	02	1006.5	6.5	7.0	8	13	27	7	13
PORTLAND	AMERICAN	7	50.1 N	128.4 W	00	20	41	5 NM	26	991.9	6.7	8.9	4	10	19	9	16.5
LONG BEACH	PANAMANIAN	7	44.1 N	143.4 W	06	26	M 48	.5 NM	07	1001.2	9.0	7.3					
CRESSIDA	PANAMANIAN	7	41.3 N	132.6 W	18	23	M 42	5 NM	01	1009.0	14.5	13.3	10	23			
VAN FORT	LIBERIAN	7	42.3 N	175.5 W	12	28	M 50	5 NM	50	1012.0	9.0	8.0					
WORLD HERCULES	JAPANESE	7	46.1 N	160.0 W	00	29	M 49	2 NM	00	1008.0	5.0	4.0	8	13			
VIOLET	LIBERIAN	7	50.1 N	174.1 W	06	27	M 47	2 NM	26	997.0	3.0	5.0			27	< 6	24.5
VAN WARRIOR	LIBERIAN	7	51.1 N	173.6 W	00	27	50	5 NM	70	998.0	4.5	8.0					
SEPTA	LIBERIAN	8	46.7 N	139.6 W	18	32	M 47	10 NM	03	999.0	6.0	8.0	8	13			
SANTA MARIA	AMERICAN	8	46.8 N	124.8 W	00	24	48	10 NM	01			9.5	10.6	6	10	27	12	32.5
SAMUEL S	LIBERIAN	8	45.5 N	132.6 W	00	27	M 55	2 NM	07	997.0		8.0	9.0	12	26	27	12	29.5
LONG BEACH	PANAMANIAN	8	42.5 N	146.4 W	06	23	M 47	.5 NM	07	1009.2	10.0	8.3					
ORIENTAL SOVERIGN	LIBERIAN	8	53.2 N	176.5 W	12	27	M 50	1 NM	26	999.0	- 2.0	4.0	7	19.5	27	12	29.5
WORLD HERCULES	JAPANESE	8	46.3 N	149.6 W	06	32	M 42	50 YD		995.0	4.0	6.0	8	18	29	9	18
VAN WARRIOR	LIBERIAN	8	50.8 N	178.9 W	00	29	45	10 NM	01	1002.0	4.0	5.0					
SAMUEL S	LIBERIAN	9	44.5 N	135.3 W	00	27	M 55	2 NM	07	1006.0	9.0	9.0	14	23			
NEWARK	AMERICAN	9	49.0 N	126.2 W	18	29	45	2 NM	02	1001.7	6.1	8.9	9	13	29	>13	19.5
AXEL JOHNSON	SWEDISH	9	15.5 N	94.8 W	00	34	52	5 NM	07	1010.0	20.8	20.8	10	26			
LONG BEACH	PANAMANIAN	10	39.9 N	157.0 W	06	27	M 48	.5 NM	07	1007.2	7.5	6.2					
GREAT LAND	AMERICAN	10	53.3 N	134.2 W	23	16	M 70	1 NM	10	993.3	6.4	7.8	12	23			
SANTA CLARA	AMERICAN	10	52.3 N	137.9 W	18	17	35	2 NM	64	994.9	5.6	6.7			17	8	39
SEALAND EXCHANGE	AMERICAN	10	49.0 N	138.5 W	18	18	30	1 NM		995.6	7.7	5.5	5	5	18	8	13
SANTA MARIA	AMERICAN	10	49.0 N	126.0 W	00	29	45	10 NM	03	1010.5	7.7	9.5	6	10	29	12	32.5
SAMUEL S	LIBERIAN	10	39.9 N	141.9 W	18	19	M 46	2 NM	07	1020.0	13.0	10.0	13	19.5			
OCEAN LOG	JAPANESE	10	39.1 N	134.2 W	12	18	M 42	2 NM	58	1018.0	8.0	11.0	8	13			
NEWARK	AMERICAN	10	49.3 N	128.8 W	00	30	45	5 NM	19	1011.9	6.7	7.7	6	13	29	12	19.5
VAN WARRIOR	LIBERIAN	10	49.1 N	163.7 E	06	23	45	2 NM	50	996.0	5.5	5.0					
KYOJU MARU	JAPANESE	11	51.1 N	133.0 W	00	18	M 46	1 NM	53	1003.0	7.0	7.0	5	11.5	13	9	13
CHEVRON HAWAII	AMERICAN	11	48.1 N	133.7 W	00	18	30	1 NM	63	1006.0	9.5	6.7	9	14.5	18	12	26.5
KINYO MARU	JAPANESE	11	51.7 N	158.4 W	00	30	M 41	5 NM	27	1013.5	0.0	4.0	6	13			
GALVESTON	AMERICAN	11	32.5 N	136.1 W	00	16	60	.5 NM		985.4	8.7	8.2	8	32.5	17	11	39
SAMUEL S	LIBERIAN	11	39.6 N	143.7 W	00	27	M 43	1 NM	10	1023.0	11.0	11.0	12	16.5	27	12	19.5
SEALAND EXCHANGE	AMERICAN	11	48.6 N	134.5 W	00	18	30	2 NM		999.0	7.7	5.5	5	5	18	8	13
SANTA CLARA	AMERICAN	11	51.8 N	137.4 W	00	17	60	1 NM	62	983.4	5.6	7.7			17	9	41
NEWARK	AMERICAN	11	52.3 N	132.8 W	00	16	30	1 NM	61	1003.7	5.6	7.8	9	16.5	17	12	23
ALBUTIAN DEVELOPER	AMERICAN	11	56.3 N	153.9 W	18	26	50	10 NM	02	1009.8	- 0.1	5.6	5	8	23	7	14.5
MELLON	AMERICAN	11	32.4 N	171.7 W	06	21	M 46	1 NM	15	1018.0	5.0	5.6	5	8			
VAN WARRIOR	LIBERIAN	11	46.5 N	158.5 E	06	27	45	5 NM	70	1000.0	0.0	3.0					
VAN CONQUEROR	LIBERIAN	11	46.5 N	173.6 E	06	18	M 42	2 NM	02	1011.0	3.0	3.0					
NEWARK	AMERICAN	12	56.1 N	136.3 W	00	15	60	1 NM	65	984.1	2.2	7.2	9	19.5	16	>13	23
ALBUTIAN DEVELOPER	AMERICAN	12	55.6 N	155.1 W	00	29	48	10 NM	02	1015.9	3.5	5.0	4	6.5	29	7	13
VAN WARRIOR	LIBERIAN	12	44.2 N	153.3 E	06	27	45	5 NM	70	1014.0	0.0	3.0					
OJI GLORIA	LIBERIAN	12	43.2 N	132.6 W	00	26	M 42	10 NM	18	1015.0	10.0						
ORIENTAL SOVERIGN	LIBERIAN	12	49.3 N	163.7 E	00	25	M 45	2 NM	26	997.0	0.0	3.0	7	13			
SANSINENA II	AMERICAN	12	53.0 N	137.9 W	06	25	45	2 NM	70	990.9	4.4	5.6	3	14.5	26	6	19.5
MELLON	AMERICAN	13	52.0 N	179.3 W	06	19	M 43	10 NM	01	1012.7	1.9	3.7	7	10			
ALBUTIAN DEVELOPER	AMERICAN	13	54.2 N	162.6 W	00	22	47	5 NM	02	1014.6	5.0	5.0	5	8	22	8	16.5
BREWSTER	PANAMANIAN	13	43.7 N	133.5 W	00	29	M 42	2 NM	07	1013.6	7.5	10.0	4	6.5	29	8	11.5

Vessel	Nationality	Date	Position of Ship		Time GMT	Wind			Visibility n. mi.	Present Weather code	Pressure mb.	Temperature °C		Sea Waves†		Swell Waves		
			Lat. deg.	Long. deg.		Dir. 10°		Speed kt.				Air	Sea	Period sec.	Height ft.	Dir. 10°	Period sec.	Height ft.
NORTH PACIFIC OCEAN		MAR.																
LEO	LIBERIAN	13	50.2 N	136.1 W	00	31	M	45	5	NM	05	1013.0	7.0	8.0	6	13	31	7	31
ORIENTAL SOVERIGN	LIBERIAN	13	47.2 N	160.9 E	00	27	M	43	10	NM	26	1011.0	- 1.0	2.0	7	16.5			
PACIFIC WING	PANAMANIAN	13	39.8 N	138.5 W	06	33	M	42	2	NM	07	1032.5	10.0	11.0	8	13			
ALEUTIAN DEVELOPER	AMERICAN	14	55.0 N	162.3 W	18	09		45	2	NM	63	1009.5	+ 2.2	3.9	4	8			
LONG BEACH	PANAMANIAN	14	39.9 N	178.2 E	06	31	M	50	.5	NM	07	992.0	7.5	7.0	8	16.5			
ATLANTIC PIONEER	PANAMANIAN	14	37.9 N	173.0 E	00	31	M	55	.25	NM	25	994.5	8.0	10.0	8	13	31	10	19.5
PACIFIC BEAR	AMERICAN	14	34.8 N	145.6 E	06	21	M	47	.5	NM	65	1011.4	13.9	17.2	4	18			
PEARL VENTURE	LIBERIAN	14	37.1 N	171.7 E	00	31		60	1	NM	07	1007.4	15.0	12.0			31	7	29.5
PRES TAFT	AMERICAN	14	43.1 N	173.3 W	18	25		45	2	NM	50	998.5	8.3	5.5	7	8	23	9	29.5
PORTLAND	AMERICAN	14	37.4 N	146.4 W	06	31		45	10	NM	03	1010.8	3.3	3.9	4	8	29	8	19.5
BEISHU MARU	JAPANESE	15	53.8 N	160.1 W	18	22	M	41	5	NM	02	1007.7	2.5	4.5	3	6.5	23	8	16.5
KYOJU MARU	JAPANESE	15	53.7 N	162.0 W	18	23	M	44	.5	NM		1007.5	4.0	3.0	5	14.5	22	9	31
ALEUTIAN DEVELOPER	AMERICAN	15	55.4 N	160.6 W	12	20		70	5	NM	60	992.9	+ 1.2	3.0					
PRES TAFT	AMERICAN	15	44.1 N	171.2 W	00	25		55	2	NM	07	1008.8	7.7	5.0	7	10	24	10	29.5
BEISHU MARU	JAPANESE	16	54.0 N	161.7 W	00	22	M	43	1	NM	02	1012.7	4.0	4.5	4	8	23	9	23
ALEUTIAN DEVELOPER	AMERICAN	16	55.7 N	158.9 W	00	23		47	5	NM	02	1012.5	0.5	4.5	4	6.5	23	10	16.5
CRESSIDA	PANAMANIAN	19	54.1 N	153.0 E	18	24	M	43	1	NM	04	1007.0	10.0	13.2	6	13	23	9	19.5
SEALAND MC LEAN	AMERICAN	21	41.4 N	170.6 E	00	08		50	.5	NM		1002.1	7.7	7.7	6	14.5			
VIOLET	LIBERIAN	23	43.6 N	161.3 E	00	35	M	45	5	NM	26	1013.0	5.0	8.0	5	8	33	< 6	13
THOMAS E CUFFE	AMERICAN	23	35.0 N	179.5 W	06	18		45	2	NM	21	1006.4	14.4	15.6	3	8	18	< 6	13
TORINITA	NORWEGIAN	23	34.9 N	162.8 E	06	32		46	10	NM	62	1016.0	8.5	13.0					
BREWSTER	PANAMANIAN	23	33.8 N	166.0 E	06	27	M	44	10	NM	03	1012.5	11.0	15.5	4	6.5	27	8	11.5
OJI GLORIA	LIBERIAN	23	38.6 N	158.0 E	06	32	M	50	10	NM	18	1018.0	9.0						
VIOLET	LIBERIAN	24	45.1 N	168.3 E	00	33	M	50	2	NM	26	1010.0	1.5	4.0	5	26	35	8	26
JAPAN RAINBOW	JAPANESE	24	39.7 N	150.5 E	12	14	M	56	.5	NM	65	1014.0	8.0	10.0			14	6	14.5
LEO	LIBERIAN	24	38.6 N	143.2 E	06	23	M	50	.5	NM	81	1005.0	14.0	17.0	7	13	23	13	41
MELLON	AMERICAN	25	52.5 N	170.6 W	00	30	M	46	5	NM	15	983.7	1.1	4.1	7	10			
UNIVERSE KURE	LIBERIAN	25	29.4 N	175.3 W	18	32	M	45	5	NM	02	1014.0	14.8	19.4	5	16.5	32	8	19.5
PLUVIUS	GERMAN	25	34.3 N	172.1 W	18	36		47	.25	NM	81	1010.5	10.2	14.0	7	16.5			
PRES TAFT	AMERICAN	25	53.5 N	173.9 W	06	34		41	5	NM	85	1000.8	2.5	1.9	10	10	02	8	24.8
UNIVERSE KURE	LIBERIAN	26	29.3 N	175.9 W	00	36	M	45	10	NM	02	1020.0	15.0	19.5	5	18	36	8	21
PLUVIUS	GERMAN	26	34.3 N	174.1 W	00	36		45	5	NM	03	1021.1	10.4	13.0	6	10	01	9	13
PRES TAFT	AMERICAN	26	50.3 N	168.3 E	18	23		41	5	NM	02	997.6	2.7		6	8	23	7	19.5
ALEUTIAN DEVELOPER	AMERICAN	26	52.8 N	174.5 W	18	18		45	2	NM	22	1007.8	2.2	1.7	3	8	15	8	11.5
GALVESTON	AMERICAN	27	57.0 N	143.9 W	18	29		44	10	NM	02	1010.5	1.0	4.4			29	9	19.5
ALEUTIAN DEVELOPER	AMERICAN	27	53.2 N	172.3 W	00	21		45	5	NM	02	1005.8	3.9	1.7	3	8	18	8	13
JAPAN BEAR	AMERICAN	28	33.5 N	124.3 W	18	36	M	48	10	NM	02	1023.5	12.2	12.2	5	14.5	33	7	19.5
GALVESTON	AMERICAN	28	57.1 N	144.3 W	00	28		45	10	NM	01	1018.3	3.3	3.9	8	26			
VAN CONQUEROR	LIBERIAN	31	39.9 N	151.6 E	12	11	M	42	2	NM	51	1011.0	6.0	10.0					
PACIFIC WING	PANAMANIAN	31	47.1 N	157.9 W	18	16	M	42	.5	NM	43	1018.0	8.0	5.0	6	6.5			
OJI GLORIA	LIBERIAN	31	42.2 N	147.0 E	18	07	M	50	5	NM	18	996.2	6.0						
NORTH PACIFIC OCEAN		APR.																
TAYABAS BAY	PANAMANIAN	2	35.2 N	155.2 W	12	14	M	45	2	NM	02	1010.0	16.2	16.0	10	14.5			
PORTLAND	AMERICAN	2	49.9 N	127.9 W	00	31		41	10	NM	02	1023.0	9.0	8.4	3	6.5			
TUNISIAN REEFER	DANISH	3	37.8 N	151.0 W	06	32		45	2	NM	63	1004.8	14.6		6	18			
PRESIDENT MADISON	AMERICAN	3	37.0 N	149.6 W	06	15	M	45	5	NM	02	1010.5	15.6	13.9	10	24.5			
PRES JEFFERSON	AMERICAN	3	34.8 N	141.9 E	12	27		45	10	NM	07	1018.0	16.1	15.6	3	5	27	>13	13
PRESIDENT MADISON	AMERICAN	4	36.5 N	162.5 W	18	30	M	65	5	NM	16	1007.2	8.9	12.3	8	37.5			
PRESIDENT MADISON	AMERICAN	5	36.1 N	163.3 W	00	34	M	55	5	NM	02	1020.0	11.7	12.2	14	29.5			
RICE QUEEN	AMERICAN	6	15.5 N	95.3 W	00	02		45	5	NM	04	1019.1	28.9	27.2	12	19.5			
RUSE	LIBERIAN	7	35.9 N	138.5 W	00	32	M	48	5	NM	03	1014.0	13.0	14.5					
GRAND CARRIER	LIBERIAN	7	43.8 N	168.0 E	12	25	M	45	1	NM	83	994.7	4.0	2.0					
ATLANTIC PIONEER	PANAMANIAN	7	36.8 N	143.2 E	06	08	M	44	5	NM	65	1006.0	13.0	21.0	6	11.5			
SEA FAN	SINGAPORE	9	49.5 N	127.5 W	00	12	M	41	.5	NM	58	1003.5	7.0						
S P LEE	AMERICAN	9	36.9 N	123.1 W	06	29	M	53	10	NM	16	1022.3	11.1	14.4					
NEWARK	AMERICAN	9	49.9 N	127.9 W	00	10		45	5	NM	61	1005.4	7.7	7.7	6	8	19	11	13
ASIA HONESTY	LIBERIAN	10	53.4 N	153.4 W	00	23	M	42	10	NM	03	991.0	9.0	9.0	5	11.5	25	6	16
LAUREL	LIBERIAN	10	39.6 N	162.5 W	18	21	M	41	1	NM	55	1008.0	12.0	12.0	5	13	22	7	16.5
MORNING GLORY	LIBERIAN	11	51.0 N	142.8 W	12	14	M	44	5	NM	51	996.0	5.7	6.0			14	8	18
YAMASHIN MARU	JAPANESE	11	42.3 N	148.4 W	12	21	M	41	2	NM	02	1011.0	12.5	9.0	6	11.5	21	8	16.5
GREAT LAND	AMERICAN	12	38.8 N	150.4 W	18	28	M	42	5	NM	71	998.5	- 0.7	6.7	10	6.5			
SEA FAN	SINGAPORE	12	34.2 N	155.1 W	18	23	M	42	5	NM	82	1003.0	- 2.0						
PACIFIC BEAR	AMERICAN	12	40.1 N	174.0 W	06	12		50	5	NM	02	1016.0	7.2	12.2	5	16.5			
PACIFIC BEAR	AMERICAN	13	41.4 N	158.7 W	18	22		45	2	NM	10	1013.0	11.2	9.4	6	16.5	20	10	16.5
JARVIS	AMERICAN	14	36.8 N	155.1 W	15	34	M	48	10	NM	01	1003.9	- 6.8	3.7	7	5			
MONTIRON	LIBERIAN	14	32.7 N	137.0 W	12	16	M	48	2	NM	60	991.0	3.2	7.0					
MONTIRON	LIBERIAN	15	34.0 N	142.9 W	06	19	M	28	2	NM	60	985.0	3.0	6.0	11	16.5	24	12	36
NEWARK	AMERICAN	15	55.0 N	142.1 W	12	11		45	5	NM	70	979.3	+ 0.5	4.5	6	14.5	09	10	19.5
VAN ENTERPRISE	LIBERIAN	16	34.2 N	138.2 E	12	27	M	47	5	NM	01	1004.5	18.0	20.0					
NEWARK	AMERICAN	16	53.9 N	138.2 W	00	25		50	.5	NM	77	986.8	2.2	6.7	7	16.5	25	12	26
QUEENS WAY BRIDGE	JAPANESE	17	39.1 N	126.2 W	00	36	M	42	10	NM	02	1025.5	12.5	9.0	4	13	36	8	11.5
SUCCESSFUL VENTURE	LIBERIAN	18	37.4 N	147.8 E	06	19	M	42	1	NM	30	999.0	17.3	19.0	4	6.5	20	6	10
DISCOVERER	AMERICAN	20	59.9 N	144.6 W	06	09	M	45	2	NM	61	1009.3	4.0	3.4	3	6.5			
GREAT LAND	AMERICAN	21	49.9 N	127.8 W	18	13	M	44	5	NM	63	1005.3	8.9	9.3	6	10			
TROPICANA	LIBERIAN	23	38.5 N	149.5 E	18	27	M	46	5	NM	13	1007.5	13.0	18.0					
MONTIRON	LIBERIAN	24	43.8 N	153.4 E	18	30	M	48	2	NM	10	1001.9	0.4	3.0	9	29.5	30	9	36
TROPICANA	LIBERIAN	25	39.4 N	161.1 E	06	27	M	46	5	NM	80	1004.0	6.0	14.0					
MONTIRON	LIBERIAN	25	42.1 N	133.0 E	00	30	M	43	2	NM	16	1007.8	1.0	5.0	7	18	30	8	28
ASIA BRAVERY	LIBERIAN	30	44.2 N	164.3 E	06	30	M	44	2	NM	02	999.3	5.0	10.0	3	6.5	30	9	18

+ Direction for sea waves same as wind direction
X Direction or period of waves indeterminate
M Measured wind

NOTE: The observations are selected from those with winds ≥ 35 kn or waves ≥ 25 ft from May through August (≥ 41 kn or ≥ 33 ft, September through April). In cases where a ship reported more than one observation a day with such values, the one with the highest wind speed was selected.

Rough Log, North Atlantic Weather

June and July 1977

ROUGH LOG, JUNE 1977--The predominant oceanic weather feature this month on the 30-day mean sea-level pressure chart was high pressure. The Bermuda-Azores High at 1025 mb was centered near 32°N, 39°W, not far from its climatological position. Ridges normally extend westward and northeastward. This month the northeastward ridge was more pronounced than usual and bulged more to the north, virtually wiping out the 1009-mb center of the Icelandic Low. There were two low-pressure centers of some significance, a 1010 mb near Montreal and a 1011 mb over Cumberland Sound.

There were two anomaly centers worthy of mention: a positive 9-mb center south of Iceland and west of Ireland, a result of the extension of the ridge into the domain of the Icelandic Low; and a negative 3-mb center off Cape Cod and south of Cape Sable from the influence of the anomalous LOW over New England.

There was not as much obvious difference from climatology in the upper air flow at 700 mb as at the surface. The trough off the east coast of the United States was more pronounced as was the ridge west of Europe and the trough immediately east of the ridge. This resulted in lower than normal heights off the U.S. East Coast, higher than normal over the eastern ocean, and lower than normal over Iberia.

The storm paths reflected the pressure pattern and its anomalies. The major storm path that affected mariners moved across the northern United States and southern Canada to off of the northeastern coast. After passing south of or over Newfoundland, the storms fanned out with no primary path. There were several cyclones that formed over the ocean. Two cyclones had distinctive southerly components to their tracks over the eastern ocean.

There were no tropical cyclones this month.

Extratropical Cyclones--The cyclones that did develope were generally weak and no real problem to large ships. The first week there was a large HIGH centered off Ireland. A LOW was pushing against the underside of the HIGH on the 3d. The original low center at latitude 46°N collapsed, and another formed near 40°N at 1200. At 1800 the NEW ENGLAND HUNTER at 48°N, 37°W, had 51-kn easterly winds. The LOW moved westward with the easterly flow south of the HIGH and turned southward late on the 4th (fig. 42). At 1800 on the 4th, the MEONIA, near 44°N, 35°W, was sailing with 54-kn easterly winds and 13-ft waves. The center of the HIGH crept slowly westward and was elongated by the 5th. At 1200 the KLAUS LEONHARDT (42°N, 34°W) encountered 40-kn gales. On the analysis of the 6th, the HIGH had split into three centers and the LOW was only a trough.

Low pressure controlled the weather over the United Kingdom and Scandinavia and a stationary front lay along 60°N on the 5th. The analysis at 1200 showed a closed LOW south of Iceland. This tightened the gradient between its center and a 1032-mb HIGH centered on 50°N. At 1800 Ocean Weather Station Lima measured 35-kn gales, and at 0000 on the 6th, the gales had increased to 50 kn with 16-ft seas. Lima was also reporting rain showers. The LOW was 996 mb near 57°N, 12°W. The cyclone was moving southeastward and expanding (fig. 43). Gales were blowing in the western semicircle with seas up to 20 ft. At 1800 a SHIP near the center reported swells of 23 ft near 51°N, 06°W.

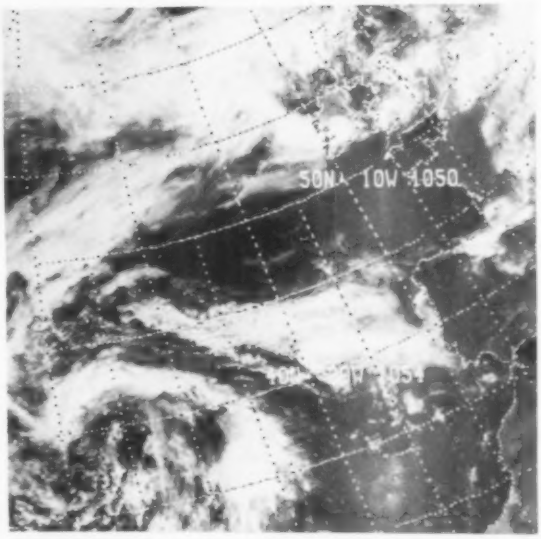

Figure 42.--The HIGH is centered near 52°N, 27°W, and the LOW is centered near 40°N, 38°W. Stratus off the coast of Portugal turns into fair weather cumulus.

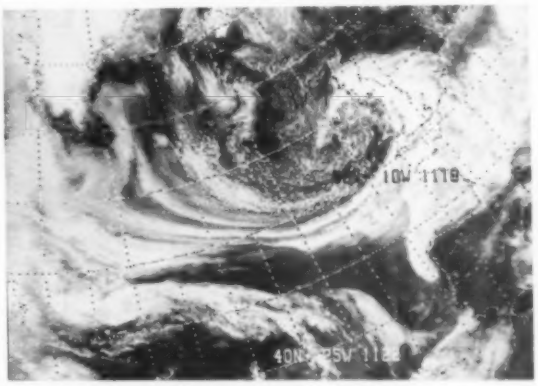

Figure 43.--At this time on the 6th the LOW is over northern Ireland, and the HIGH has split into two centers--one south of Kap Farvel and the larger one west of Gibraltar.

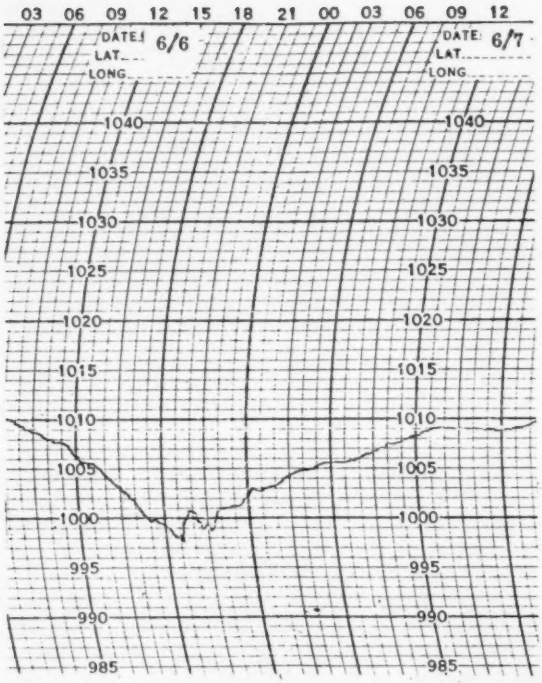

Figure 44.--This barogram from the Chesapeake Light Station east of Norfolk indicates the passage of the LOW, and the rise in pressure at the bottom of the trace indicates the thunderstorms.

By the 8th this LOW had absorbed the other centers and was moving northward along the coast of Norway.

A weak front moved off the east coast of the United States on the 3d, and a wave formed east of Long Island. The wave moved northward along the front to Nova Scotia, where it stalled until the 5th. On the 6th it was moving southeastward, and a few gales were reported early in the day. Another LOW was moving across the Great Lakes. The combined LOWs had a large circulation which stretched from the central Great Plains to midocean. The BARON MACLAY(46°N, 53°W) was pounded by 54-kn winds at 1800, and a ship on the St. Lawrence River reported 52-kn winds. At about 2000 the western LOW moved across the Delmarva Peninsula, and at 2030 severe thunderstorms struck the area with gusts to 85 kn (fig. 44). Many sailboats were overturned and the 42-ft fishing party boat DIXIE LEE II (fig. 45) capsized when she was hit by 15-ft waves off Norfolk in the Chesapeake Bay. Thirteen of the twenty-seven people on board died. Hail the size of golf balls was reported in some areas, and a hangar at the airport was severely damaged. The storm also destroyed 600 ft of a fishing pier, and the roof of an apartment building near the pier was blown off. Several tornadoes were reported around the Norfolk area. Heavy rains of 1 to 1.5 in were reported in as little as half an hour. The LOW turned northeastward again on the 7th. The TOPDALSFJORD reported 63-kn winds northeast of the center and past weather of thunderstorms. On the 8th the western LOW was the major cyclone as it turned northward to the Labrador Sea. The eastern LOW raced eastsoutheastward under zonal flow. On the 9th and 10th the LOW stalled south of the Azores. It dissipated

Figure 45.--Coast Guard divers rest on the partially sunk DIXIE LEE II during their search for bodies of the missing. Wide World Photo.

off the African coast on the 11th.

This storm originated near Winnipeg, Canada, on the 6th. On the 10th the center crossed the coastline near Atlantic City, N.J. At 1200 the first strong wind report of 46 kn was transmitted by the AMBARTCHIK off Cape Cod. At 0000 on the 11th, the 996-mb LOW was near 40°N, 70°W. There were several 35- to 45-kn gale reports within 100 mi of 39°N, 71°W. The highest seas and swells were 20 ft. On the 11th, 12th, and 13th the cyclone moved slowly northward to New Brunswick and weakened. On the 14th it was headed northeastward.

On the 16th a front curved from Iceland to South Carolina. The pressure gradient was weak between it and the coast of North America, and stable waves were moving along the front. At this time a LOW which had originated over the St. Lawrence Valley moved over Newfoundland. At 1200 on the 17th, a double LOW cyclonic circulation was east of Newfoundland. Two ships south of the southern center reported 35-kn gales along the trough line. On the 18th the LOW consolidated near 54°N, 50°W, at 990 mb. The USCGC EVERGREEN (52°N, 52°W) had 44-kn northwesterly winds (fig. 46). The C.P. TRADER was east of the LOW with 37-kn gales and 16-ft seas. There were isolated minimal gale reports as the cyclone wandered over the Labrador Sea before turning northeastward. On the 22d OWS Lima measured 35-kn winds and 15-ft waves as the storm neared 63°N, 35°W. On the 23d it broke into two centers and moved eastward over the Norwegian Sea.

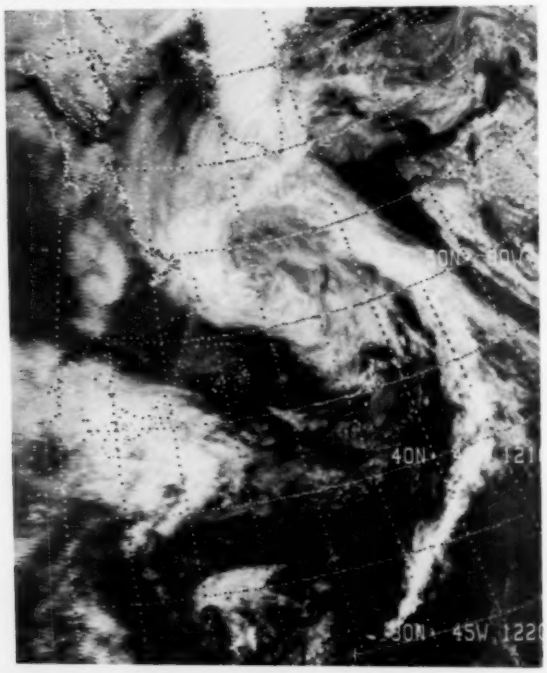

Figure 46.--Near midday on the 18th, the LOW is consolidating for a punch at the EVERGREEN. High, thin clouds obscure the center.

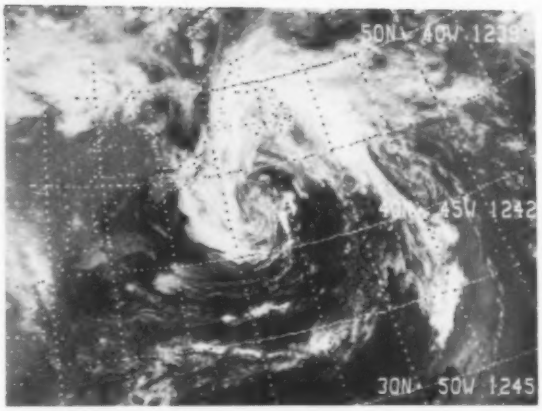

Figure 47.--The stronger winds with this storm are east of the center and the front. The cold front is very weak, but there appears to be a large squall area south of the warm front and 40°N, 45°W.

This LOW formed at the point of occlusion of a frontal system as it moved off Long Island late on the 26th. At 1800 the FNYC was hit by 52-kn winds from the south near 40°N, 58°W. At 0000 on the 27th, the DORIC had 42-kn gales on her starboard side as she sailed down the coast. The FNYC was about the same distance ahead of the storm at 1200 with 44-kn winds. At 1200 on the 28th, the 1000-mb storm was centered near 42°N, 58°W (fig. 47). The FNYC, still sailing eastward along latitude 41°N, had 38- and 56-kn winds at longitudes 46°W and 42°W at 0000 and 1200, respectively.

The storm weakened as it passed near the Grand Banks, but it gained new life after passing into mid-ocean. At 1200 on the 30th, the 992-mb LOW was near 54°N, 36°W, and the PAMIR was near 53°N, 37°W, with 994-mb pressure and 42-kn winds. At 1800 OWS Charlie measured 44 kn. At the same time on July 1 the DISCOVERY (58.6°N, 31.5°W) had 995-mb pressure, 45-kn northerly winds, and 25-ft seas. On the 2d, a ship 300 mi south of the LOW had 20-ft swells.

On the 3d the LOW was stacked vertically with the upper air LOW and remained stationary near 60°N, 20°W, until it dissipated on the 5th.

Casualties--The 8,300-ton Canadian icebreaker ferry WILLIAM CARSON sank early on the 3d after striking an iceberg in the Strait of Belle Isle. All 128 passengers and crewmembers were rescued by helicopter and the Coast Guard icebreaker SIR HUMPHREY GILBERT. The drilling rig OCEAN MASTER II while under tow sank in rough seas off the Nigerian coast the second week of the month.

During late May and early June the PAUL LORENZ RUSS (4,475 tons) suffered ice damage in the Strait of Belle Isle while bound for the Great Lakes. The 1,450-ton CHEMIE CARRIER arrived Curacao with heavy weather damage sustained on the 17th during a voyage from Houston.

Four men in a banana-shaped leather boat reported that everything was okay while 250 mi north-northeast of St. Anthony, Newfoundland, on the 15th. On the 14th they were caught in pack ice, but a fishing vessel

escorted them 15 mi through the ice. They were on the final 250-mi leg of a 4,000-mi voyage across the Atlantic from Ireland to Newfoundland. The crew was trying to demonstrate that St. Brendan, a famous early medieval Irish navigator, could have discovered America 1,000 yr before Columbus.

ROUGH LOG, JULY 1977--The majority of cyclones this month were concentrated over northern Canada and the Labrador Sea. Over the water area the primary path was from Labrador eastward and northeastward toward Iceland. The northeasterly storm track off the U.S. East Coast was only lightly traveled. One storm from Spain and the Mediterranean traveled across central Europe. Two cyclone centers passed north of Scotland into Scandinavia, where they turned sharply northward.

The monthly mean pressures did not differ greatly from climatology. The largest and primary feature over the water was the Bermuda-Azores High at 1029 mb. Its center was near 38°N, 31°W, or about 400 mi northwest of its normal 1025-mb position. There were three low centers over or near the northern waters verses the normal two. A 1011-mb center was near 62°N, 28°W. A 1005-mb center at 56°N, 58°W, and a 1006-mb center at 61°N, 75°W, replaced the normal 1008-mb center near Cape Chidley. The pattern followed the basic configuration with ridges stretching toward the southeastern United States and northern Europe.

There were two areas of significant anomalous pressures. One large, positive area occupied the northeastern quarter of the ocean from latitude 30°N northward. A narrow neck of this area stretched across the Norwegian and Barents Seas to another center over Siberia. A negative area was centered over the Labrador Sea off Hamilton Inlet.

The upper air pattern at 700 mb differed in several significant aspects from climatology. The High over midocean was several meters higher than normal, and the center shifted eastward from near 30°N, 50°W, to 36°N, 38°W. The low-pressure trough that normally parallels Canada's northeast coast was wider than usual with a closed LOW near 62°N, 77°W, over Cape Wolstenholme. The low-pressure trough over and along the western European and northwest African coasts was much sharper than usual.

There were the usual number of disturbances in the Tropics, but none developed into tropical storms or hurricanes. This is not highly abnormal as nearly one-third of the seasons this century did not produce tropical cyclones in June or July. The longer the season progresses without a tropical cyclone, the more abnormal it becomes.

Extratropical Cyclones--The dominant feature over the water this month was high pressure. The cyclones were forced well to the north, and except for three isolated occurrences off the U.S. East Coast, there were no storm centers south of 49°N. Most of the storm centers tracked north of latitude 55°N, except in the Labrador Sea.

This storm formed on the 5th over the St. Lawrence River at latitude 48°N, but it was above 50°N by the time the center was over open water. At 1200 on the 6th, it was 995 mb over Newfoundland (fig. 48). The SAGUENAY was in the Gulf of St. Lawrence with 55-

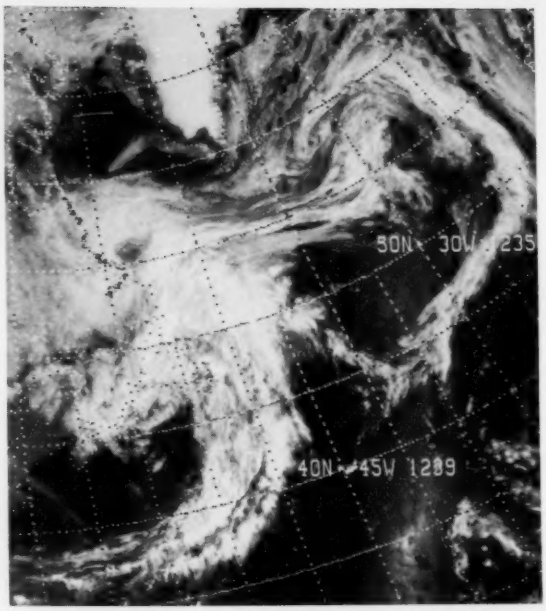

Figure 48.--The storm is centered over Newfoundland producing a large cloud cover over the cold water of the Labrador Sea. A small cyclonic circulation can be seen near 58°N, 34°W.

kn winds from the north. At 0000 on the 7th, a Swedish ship reported 48-kn winds off the Gaspe Peninsula. The PIONEER COMMANDER was near the front at 49.8°N, 42.7°W, with 42-kn southerly winds and 18-ft seas. At 1800 the oil/ore carrier H1070 had 50-kn easterly winds about 150 mi southwest of Kap Farvel.

On the 8th the LOW was weakening rapidly, but there were still strong winds along the front. The CETRA COLUMBA and DGCE were near the front in the vicinity of 43°N, 44°W, with 63- and 60-kn winds, respectively. By the 9th the LOW had completely filled.

As the point of occlusion of a frontal system moved over Goose Bay, Labrador, on the 14th, a closed LOW was analyzed. At 0000 on the 15th, the IVAN MOSKVIN, south of St. Mary's Bay, radioed 48-kn winds and 12-ft seas. On the 16th the CHEMBARGE was north of Belle Isle with 44-kn winds. The LOW was racing eastward at about 30 kn (fig. 49) and at 1200 was 1000 mb near 58°N, 25°W. As the storm approached Rockall Bank, it slowed and deepened slightly to 993 mb at 1200 on the 17th. Ocean Weather Station Lima reported 35-kn winds as the center moved north of her position. Two ships near 56°N, 14°W, also had 35-kn gales with one reporting 16-ft seas. On the 19th the LOW stalled over Norway and the AMERICAN LEGEND had 40-kn winds in the North Sea. On the 20th the storm moved over the Norwegian Sea and broke into multiple centers.

This LOW formed in an area of weak pressure gradient over south central Canada on the 16th. On the 18th it moved over the Labrador Sea. On the 19th at 0000 the

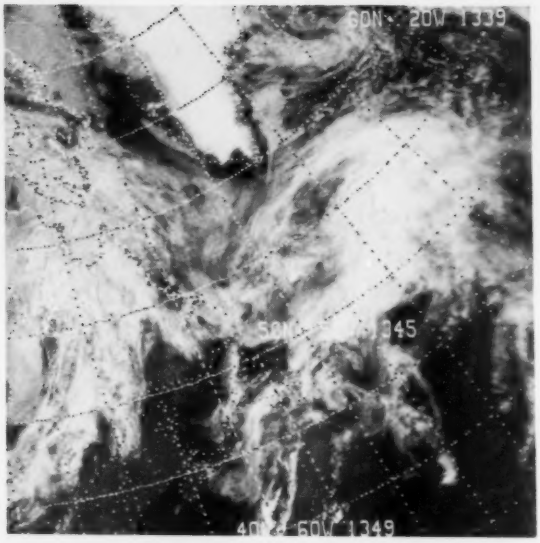

Figure 49.--This storm did not take time to assume the classic appearance as it raced eastward.

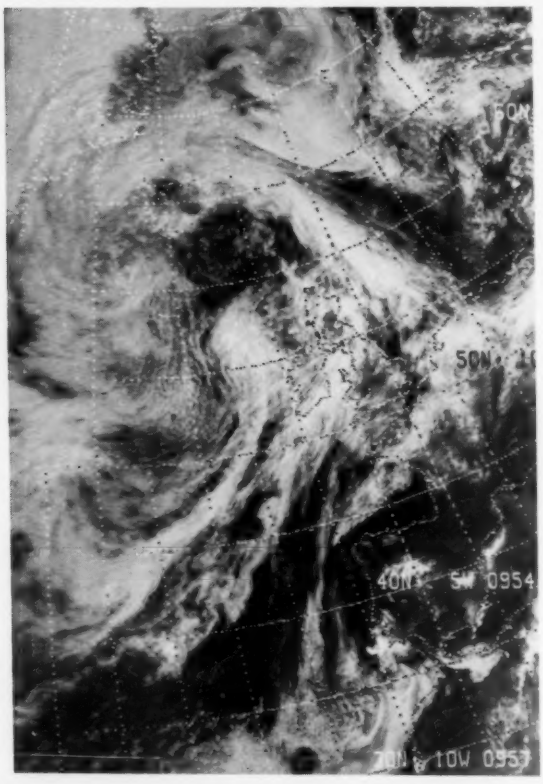

Figure 50.--At this time on the 23d, the LOW is at 62°N, 28°W. A large vorticity center on the front is approaching Ireland. One of the new centers later developed under its influence.

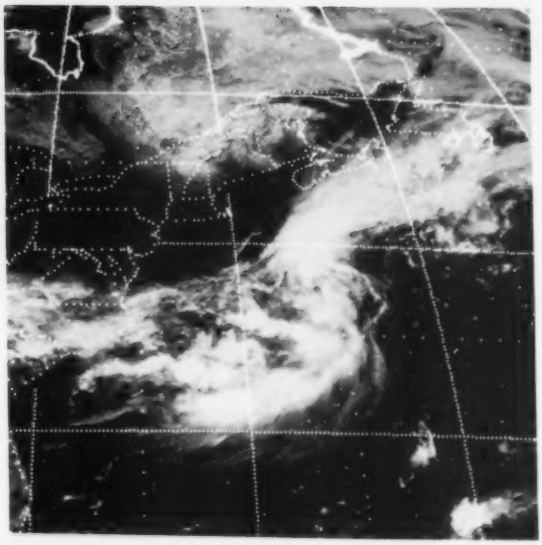

Figure 51.--Ship observations indicated that the LOW formed south of the front, rather than on it as verified by satellite.

ZIM NEW YORK was sailing toward her namesake with 40-kn winds near 42°N, 48°W. On the 20th and 21st, the storm had multiple centers, but by the 22d it had again consolidated into one center. On the 21st the GRONLAND was near Kap Farvel with 37-kn easterly winds. On the 22d the MINDEN was south of Iceland with 44-kn winds. The LOW had been on a northerly track but turned southeastward late on the 23d. At 1200 the NQDO was on the Irish Sea with 56-kn winds. Two ships had 40-kn gales south of the center (fig. 50).

The storm broke into multiple centers again on the 24th, with the primary center jumping to just west of Scotland. Lima reported 35-kn winds and 13-ft seas. A ship in the English Channel reported 48-kn winds on the 25th. The center made a clockwise loop over Scandinavia on the 25th and 26th before heading due north into the Greenland Sea.

This storm formed some distance off the Virginia coast as a front pushed southeastward on the 22d (fig. 51). At 1800 the ATLANTICA MILANO was on the east side with 52-kn southerly winds. The seas were coded as 39 ft accompanied by 23-ft swells. By 0000 on the 23d, the LOW was 999 mb near 40°N, 63°W. The SUGAR TRADER (39°N, 65°W), north of the front, and the YUKON (36°N, 63°W), south of the front, both had 40-kn winds with 120° difference in direction. The ATLANTICA MILANO now reported 30-kn winds with 10-ft seas and 25-ft swells. At 1200 four U.S. ships reported 40- to 50-kn winds around the storm. They were the ALMERIA LYKES, C.V. LIGHTNING, SEA-LAND PRODUCER, and WASHINGTON TRADER. Late that day the 990-mb storm raced over St. John's toward Greenland and continued up its west coast.

Casualties--The 1,567-ton Panamanian-registered SUPREME BEAVER was at Curacao on the 6th with heavy weather and contact damages.

Rough Log, North Pacific Weather

June and July 1977

ROUGH LOG, JUNE 1977--The main features this month were high pressure centers: the Pacific High off the west coast of the United States, a HIGH south of Kamchatka, and another over Saint Matthew Island in the Bering Sea. There were more cyclones than usual, but they were generally small and weak. Their primary path was from slightly south of Japan eastward to near 160°W where they turned northeastward to the Gulf of Alaska. A secondary path extended from the Kuril Islands to the Aleutians to dissipate near the Alaska Peninsula. Although they did not affect shipping, there was a series of storms over eastern Siberia, west of the Bering Strait.

The monthly normal sea-level pressure pattern did not differ greatly from climatology. There were two principal low-pressure centers: one south of the Rat Islands at 1011 mb and another over southwestern Alaska at 1013 mb. These were 1 and 2 mb higher, respectively, than their climatological counterparts. There was an anomalous 1015-mb HIGH between and slightly north of the two LOWs. The Pacific High at 1025 mb was near 38°N, 137°W, 1 mb higher in pressure than its climatological mate which is normally at 34°N, 145°W. The other high-pressure center was 1016 mb near 43°N, 162°E.

There were many weak anomaly centers. The highest in pressure was plus 4 mb south of Kamchatka in conjunction with the high-pressure center. A small, positive 3-mb center was over the Bering Sea with that high-pressure center, and an elongated positive 3-mb area paralleled the west coast of the United States. The largest negative area (minus 3 mb) covered a relatively large area between Hawaii and Alaska.

In the upper air the 700-mb heights averaged higher than climatology with the exception of over the Gulf of Alaska and into the Mackenzie Mountains. The pressure centers were shifted westward, especially the HIGH along latitude 30°N, but the troughs and ridges along the coasts remained normally located.

Tropical storm Ruth moved northward out of the South China Sea through the Formosa Strait in the middle of the month. Over the Eastern North Pacific tropical storm Ava[1] formed during the last week of May and tropical storm Bernice in the last week of June.

Extratropical Cyclones--Happily for mariners this was a quiet month over the North Pacific. There were many small LOWs and frontal waves, but only a few developed into major storms.

One of the more severe storms originated over the central ocean as a frontal wave on the first day of the month along 30°N. It was a maverick from the start. On the 2d it turned northward and then northwestward before taking an almost due north track until the 6th.

[1]Tropical storm Ava will be described in the November issue of Mariners Weather Log in the Smooth Log for May.

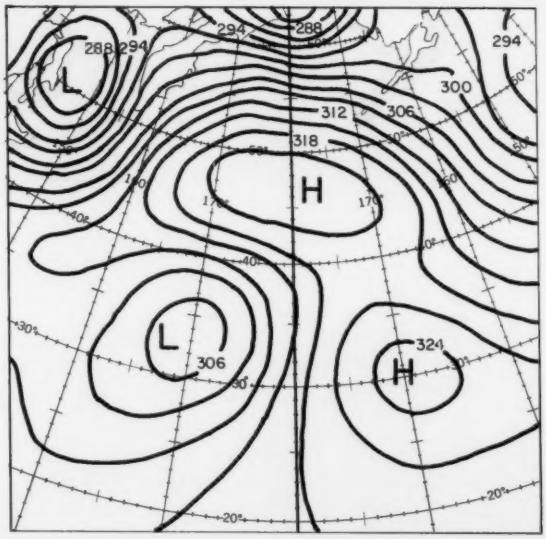

Figure 52.--This 700-mb analysis for 0000 June 4 shows the relationship of the cutoff LOW to the other pressure centers.

Its direction was controlled by an upper air cutoff LOW with HIGHs to the north and east blocking its movement (fig. 52). At 0000 on the 3d, the LOW was 998 mb near 35°N, 172°E. The JRDT was less than 60 mi northeast of the center and reported 16-ft seas and 26-ft swells. At 1200 she moved northwest of the center with 20-ft seas and 26-ft swells. The TAISAN MARU was north of the center near latitude 40° with 35-kn easterly winds and 16-ft seas (fig. 53). At 0000

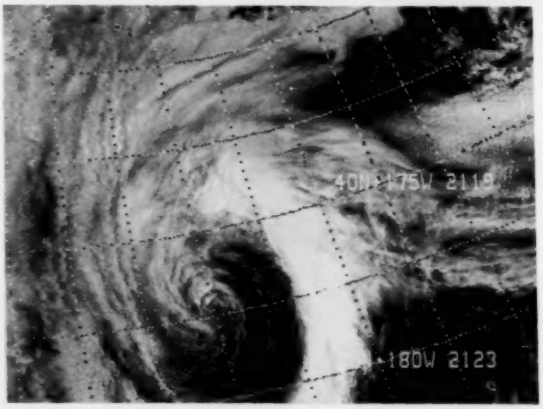

Figure 53.--The surface LOW was at 36°N, 170°E, at 2120 on the 3d and north of the upper air center. The surface HIGH is near 47°N, 175°W.

on the 4th, the LOW was on its northerly track at 993 mb. The JAPAN RAINBOW was in the southwest quadrant at 30°N, 166°E, with 60-kn northwesterly winds and 13-ft waves. There were several reports of 35-kn winds and 16-ft waves north of the center.

By the 5th the upper air LOW had deteriorated to a trough, and the northern high-pressure center had moved southeastward to join with the stronger eastern HIGH. The surface storm was weakening as it lost upper air support. The LAUREL was east of the center with 35-kn winds. At 1200 on the 6th, the storm took a sharp turn eastward as it moved around the upper air ridge. On the 8th it again turned northward to die over the Bering Sea on the 10th.

On the 8th the 1032-mb Pacific High was pressing against the U.S. West Coast. A 1002-mb thermal LOW was stationary over the Gulf of California. The pressure of the HIGH increased and the LOW decreased tightening the gradient. At 1800 the ORIENTAL EDUCATOR was southwest of San Francisco with 62-kn winds and 20-ft waves. The KLHZ was headed northwestward out of San Francisco at 0000 on the 9th (fig. 54) with 36-kn winds and 15-ft seas. At 1200 the

Figure 54.--The northerly winds along the coast cause the upwelling of cold water and the formation of low stratus and fog over the water.

winds were 39 kn and seas 20 ft off Cape Mendocino. A SHIP off Cape Blanco had 50-kn winds. At 0600 on the 10th, the ENDEAVOR off Cape Disappointment reported 76-kn winds. The isobars were piled up on the west side of the coastal mountains. On the 11th the gradient relaxed as both pressure centers weakened.

This was another storm born on a frontal wave. It began on the 11th near 34°N, 155°E, and traveled eastward. By 0000 on the 13th, the LOW was 998 mb near 40°N, 179°W. The POST CHALLENGER (36°N, 179°E) in the warm sector south of the LOW had 45-kn winds. This LOW was catching up with another LOW to its north and turned northwestward on the 14th to absorb it. The PRESIDENT MADISON (50°N, 169°W) was north of the center at 0000 with 40-kn easterly winds.

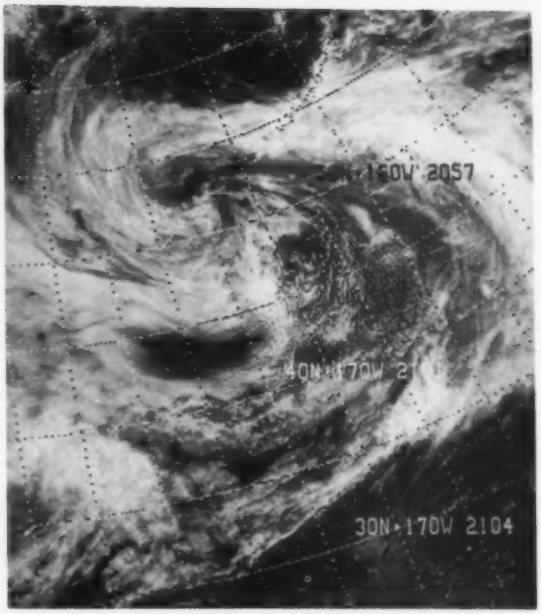

Figure 55.--The LOW has turned northwestward and passed astern of the PRESIDENT MADISON. It now has a large cyclonic circulation for a summer storm.

At 1200 the LOW was 986 mb, one of the deeper LOWs of the month (fig. 55). Minimal gale-force winds were reported around the storm. On the 15th the storm again turned eastward and was absorbed by another LOW on the 17th.

This storm formed off Hokkaido on the 13th. It was 1000 mb near 42°N, 150°E, at 1200 on the 14th. The ZINYUU MARU was southwest of the center with 40-kn winds. On the 15th other ships were reporting 35- to 40-kn winds in the vicinity of the storm. At 0600 on the 16th, the FEDSTEEL was in the southeast quadrant with 42-kn southwesterly winds. The seas were 10 ft. The storm continued to move eastward, but it was weakening rapidly and disappeared on the 19th.

A front had lain across southern Japan since the 15th. Waves were rippling along the front bringing rain to most of the islands. Downpours lashed Kyushu on the 15th and 16th causing floods and landslides. At least 1,400 homes were flooded. Up to 11 in of rain were reported with several locations reporting about 7 in. Trains were cancelled as the tracks were inundated. Earlier on the 10th the area had received heavy rains of up to 5 in with flooding and landslides. On the 18th an unstable wave was analyzed over southern Kyushu. It developed into a closed circulation as it moved eastward. The EMMA OLDENDORFF reported 37-kn winds near the center with rain showers. The MONTANA was southwest of the storm with 35-kn gales at 0600 on the 19th. At 1200 the ASIA GOLD (34°N, 150°E) was 5° longitude east of the storm with 42-kn winds. The PACIFIC WING was about 100 mi east of the center at 0000 on the 20th with thunderstorms and seas of 18 ft.

The storm continued moving east-northeastward under zonal west-to-east upper air flow with mainly breeze-force winds. On the 22d it turned more northeastward and started to deepen. The PRESIDENT TAFT was over 600 mi northeast of the center with 35-kn winds and 13-ft waves. At 1800 the JAMAICA MARU was hit by 40-kn winds and 6 hr later had 48-kn with 18-ft waves at 44.7°N, 160.1°W. The LOW was 986 mb near 45°N, 157°W. The ARNOLD MAERSK (43°N, 150°W) radioed 40-kn winds and 20-ft seas at 0600 on the 23d. At 1800 the WVFX (44.5°N, 149.7°W) was sailing into 42-kn winds, 20-ft seas, and 26-ft swells. The LOW now was in the Gulf of Alaska and dissipating rapidly.

This storm generated on the same frontal system and in basically the same air mass as the previous storm. Many minor waves had developed and dissipated on the front as it wandered south of Kyushu. This wave was first analyzed late on the 19th. On the 22d the storm was near 39°N, 159°E, at 1000 mb, when a ship reported 16-ft swells south of the center. At 1200 a ship northwest of the center had 40-kn gales. At 0000 on the 23d, there was a rash of 35- to 40-kn winds south and west of the 1000-mb storm. The highest waves were 15 ft.

The storm was 987 mb near 45°N, 156°W, at 0000 on the 25th. The JAPAN BEAR was about 180 mi south of the center with 26-ft seas and swells. Gale reports continued through the day. On the 26th there was one report of 37 kn south of the storm, but late that day it no longer existed.

The same front that separates Polar and Tropic air and generated the two previous storms also spawned this one. This frontal wave formed in midocean southwest of the previous storm late on the 24th. At 0600 on the 26th, a ship east of the center had southerly gales. At 1800 that day and at 0000 on the 27th, the PACIFIC ARROW reported 40-kn gale-force winds and seas to 16 ft near 44°N, 156°W. At 0000 the YAMASHIN MARU (45°N, 155°W) had westerly 47-kn winds and 26-ft waves. The BEISHU MARU was surprised by 54-kn winds from the south about 300 mi east of the center at 0600 (fig. 56). Late on the 28th, the

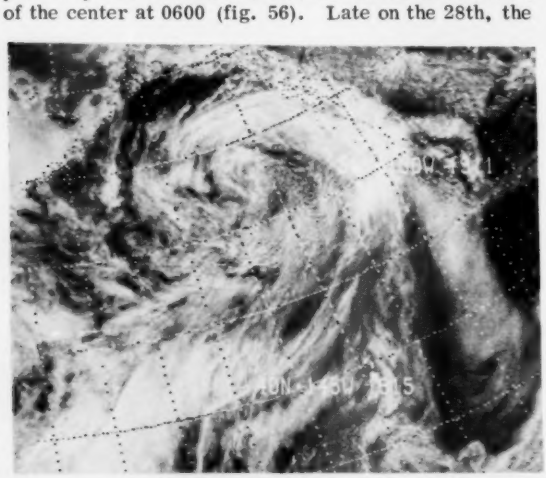

Figure 56.--The LOW blankets the Gulf of Alaska.

Figure 57.--The storm has taken a circular configuration as it spins over midocean.

LOW moved inland over Queen Charlotte Island. The WESTWARD VENTURE (back cover), which recently joined the West Coast fleet, added her contribution to the greatly valued marine weather observations.

Some kind of record must have been set by this continuous frontal boundary across the North Pacific. It had wandered between 30° and 45°N since about the 12th without a break except near the North American coast as the LOWs dissipated. This wave formed on the front on the 28th near 36°N, 160°E. The storm developed rapidly, and it was 995 mb near 38°N, 170°E, at 1200 on the 29th. The OHTSUKAWA MARU was about 120 mi northwest of the center with heavy rain, 45-kn winds, and 18-ft waves. On the 30th there were several reports of gale-force winds around the storm, especially in the eastern quadrant. The highest waves were 20-ft swells. Late on the 30th and on July 1 and 2, the LOW stalled near 42°N, 175°E (fig. 57), as it became nearly vertically alined with the upper air LOW. On the 2d a ship reported 20-ft seas. On the 3d and 4th the LOW drifted in the same area and filled.

Tropical Cyclones, Eastern Pacific--The tropical depression that was soon to become tropical storm Bernice was found on the 25th languishing near 13°N, 109°W. Traveling west-northwestward, the system was named on the 26th as winds climbed above 35 kn. However, conditions were not favorable for further intensification (fig. 58), and Bernice remained a minimal tropical storm throughout her brief life which ended near 19°N, 120°W, on the 28th.

Tropical Cyclones, Western Pacific--After more than 2 mo of inactivity, the South China Sea spawned tropical storm Ruth. She formed on the 14th about 300 mi west of Manila. Heading northward, she intensified. Winds near her center reached a peak of about 60 kn on the 15th near 20°N, 117°E (fig. 59). Ruth turned

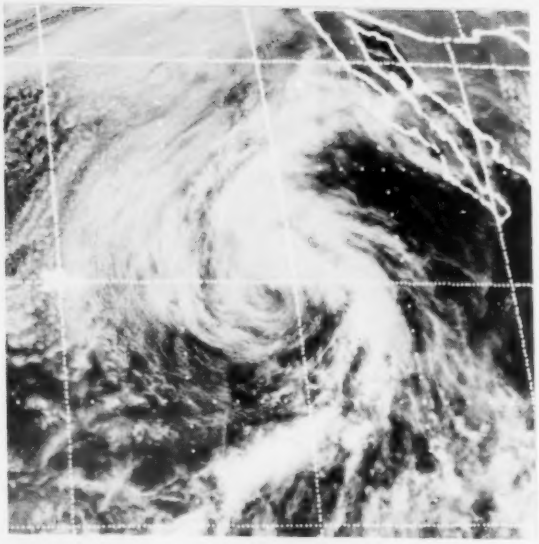

Figure 58.--Tropical storm Bernice near peak intensity at 2045 on the 27th.

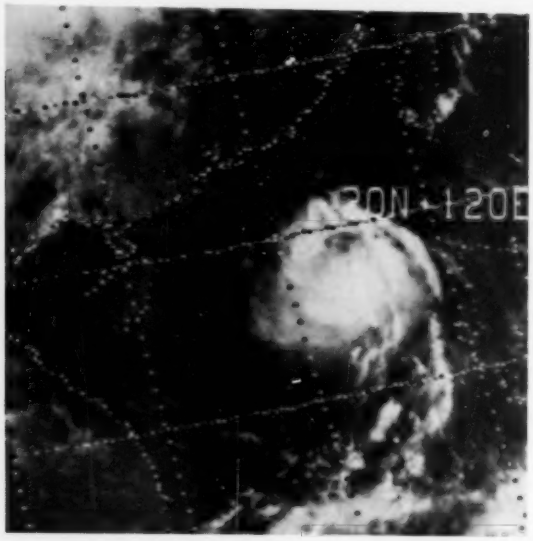

Figure 59.--Tropical storm Ruth is spinning over the South China Sea early on the 15th.

toward the north-northeast and moved across the Formosa Strait, brushing the coast of mainland China on the 16th. She then turned northeastward but lost strength and dissipated in the East China Sea.

Casualties--The first weekend of June was bad for low visibility around Japan. Early on the 5th, the 999-ton MIKI MARU and the 3,854-ton Panamanian SINAN SARI collided off Cape Trako in fog. That night the 496-ton TOYO MARU and the Soviet passenger ship FELIKS DZERZHINSKIY scraped each other off Cape Kinkayan in fog. There were no injuries in either case. On the 30th the 1,131-ton LPG carrier TAIWA MARU and the 12,690-ton Panamanian freighter CHUENOMON collided in fog on the Inland Sea.

The South Pacific also has its share of casualties owing to bad weather. The Liberian VILLANGER had cargo shifted in the Gulf of Penas on the Chilean coast on the 21st and arrived Puerto Montt with an 8-degree list and foredeck damage.

ROUGH LOG, JULY 1977--The only distinct concentration of storm paths this month was in the higher latitudes north of 50°N. There were only a few storm tracks south of that latitude. One started south of 30°N and tracked into Alaska. There was one primary track out of the Asian continent into the Sea of Okhotsk, but most of the storms were then diverted northward by anomalous high pressure north of Alaska. Only one significant cyclone formed off Japan, and it wandered into the Bering Sea. There was a favorite path across the Gulf of Alaska between latitudes 50° and 55°N. This was the only track that matched its climatological counterpart.

The mean pressure pattern was one large area of high pressure. The only closed LOW near the ocean was the usual heat LOW near the desert southwest and northwest of Mexico. The Pacific High was normally centered near 40°N, 150°W, at 1028 mb, or 3 mb higher than climatology indicates. There was an anomalous 1023-mb HIGH centered north of Point Barrow. The only indication of low pressure over the northern ocean was a trough in the Gulf of Alaska.

The most important anomaly was a plus 12-mb center associated with the high-pressure center north of Alaska. There was a negative 3-mb center over the Gulf of Alaska associated with the trough. Except for that negative center, the remainder of the ocean north of about 25°N basically reflected positive values.

The surface High north of Alaska was reflected in the 700-mb height over that same area. There was a closed Low over the Bering Sea that was not reflected at the surface. This Low, combined with higher values for the High over the central ocean, produced a tighter gradient across the 40° to 50°N latitude band. In general, heights were lower than normal for a 10° to 20° latitude band that stretched eastward from the central Bering Sea across Canada.

Three typhoons--Sarah, Thelma, and Vera--and tropical storm Wanda roamed the western ocean during the last 2 weeks of the month. Hurricane Claudia patrolled the eastern ocean.

Extratropical Cyclones--The cyclones, except for the tropical variety, were weak this month. The winds reported and the strongest waves would be considered insignificant for a winter month.

This was the long-lived storm mentioned earlier that started south of 30°N over the western ocean on the 3d and ended over Alaska on the 12th. It seemed to pop out of nowhere on the 0000 analysis of the 3d, near 29°N, 152°E. The pressure and height gradients were very flat over that area of western ocean from the surface through 700 mb. Observations were scarce. The LOW drifted northeastward and then northwestward, turning northeastward again on the 6th. At 0000 on the 8th, the 1002-mb LOW was near

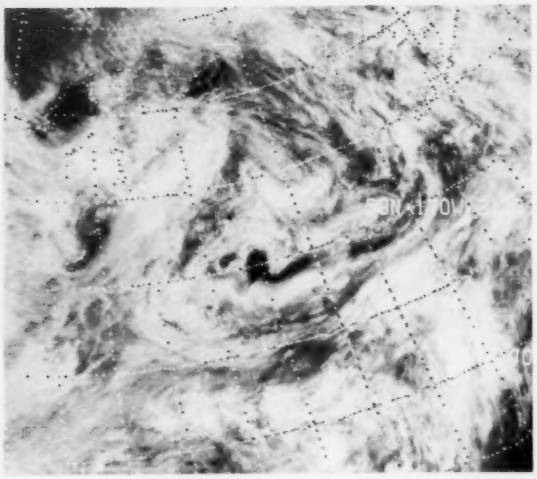

Figure 60.--At this time on the 7th the only indication of the storm on this image is a mass of thick, high clouds. Without ship observations, the storm could have gone undetected at this stage of development. The anomalous clear area (50°N, 175°E) is the result of a ridge bulging westward.

41°N, 162°E (fig. 60). The reliable reporter ASIA BOTAN was northwest of the center with 62-kn winds. A ship about 400 mi southwest of the center had 16-ft seas. On the 11th the LOW reached its lowest pressure of 996 mb and slowly filled from that point as it moved across the Alaska Peninsula to disappear over the Seward Peninsula on the 12th.

The Pacific High, centered near 40°N, 140°W, during the first part of the month, started moving westward on about the 16th. On the 20th it was 1035 mb near 42°N, 165°W (fig. 61). A front was pressing from the northwest edge, and a small HIGH formed northwest

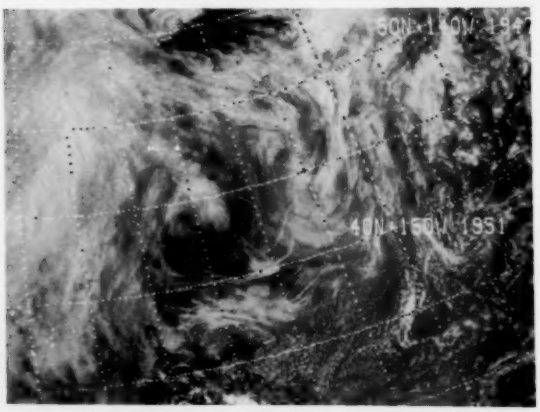

Figure 61.--The HIGH is centered near 42°N, 162°W. There is a slight indication of a circulation in the clouds near 50°N, 175°W. Note the cloud streets that resemble contrails south and east of the center of the HIGH.

of the front. This brought a cyclonic circulation, and late on the 20th a cyclone developed near 50°N, 177°W. At 1800 on the 21st, the MIHO MARU (52°N, 168°W) had 44-kn winds and 16-ft swells. Six hours later she had 40-kn winds 250 mi southwest of the 992-mb center, which was at 55°N, 164°W. On the 23d the AMERICAN LARK was just south of the cold front (44°N, 152°W) with 16-ft swells. Later that day the HILLYER BROWN was sailing toward Alaska with 35-kn winds. About this time the Pacific High started breaking down, and the LOW turned southeastward and filled to 1025 mb by the 25th. A distinct circulation was apparent until the 28th.

Cyclogenesis with the formation of a LOW and frontal system occurred over the Sea of Okhotsk late on the 20th. By 0000 on the 23d, the 996-mb LOW was near 53°N, 173°E. The GLADIOLUS was near 42°N, 167°E, with 42-kn winds and 13-ft waves. Six hours later the winds had dropped to 36 kn, but the waves increased to 15 ft as she moved with the storm. On the 24th the storm was over the Bering Sea and turned westward. The circulation still extended south to 45°N. The FRIENDSHIP was near 50°N, 169°E, with 35-kn gales on the 25th, but late that day the LOW was absorbed by another which had approached from the west.

As the above LOW retreated westward, another LOW developed in its wake over the Bering Sea. It increased its area of influence and moved eastward rapidly. It was 984 mb near 57°N, 167°W, on the 26th. The PACBARON was in the southwest quadrant with 45-kn winds. At 1800 the GLADIOLUS had sailed to 45°N, 163°W, and now had 42-kn winds with 13-ft seas (fig. 62). A report without a call sign from 49°N, 164°W, on the 27th indicated westerly 54-kn winds and no seas. The GLADIOLUS was moving along 44°N with the storm and faithfully reporting. Her winds were in the 40-kn category. On the 29th the storm stalled over the Gulf of Alaska.

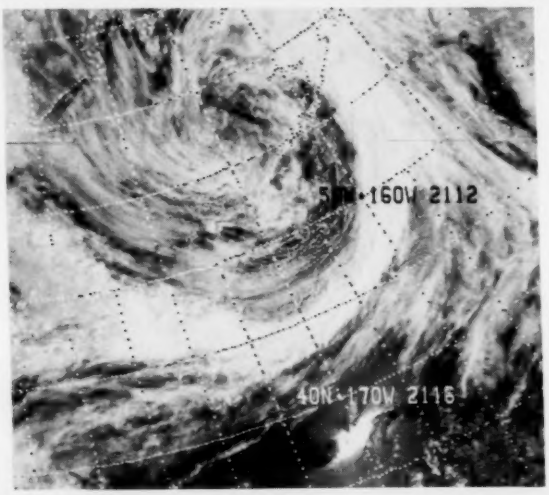

Figure 62.--The bright white appearance of the cold high clouds along the front and the cumulus toward the center is more like a winter storm.

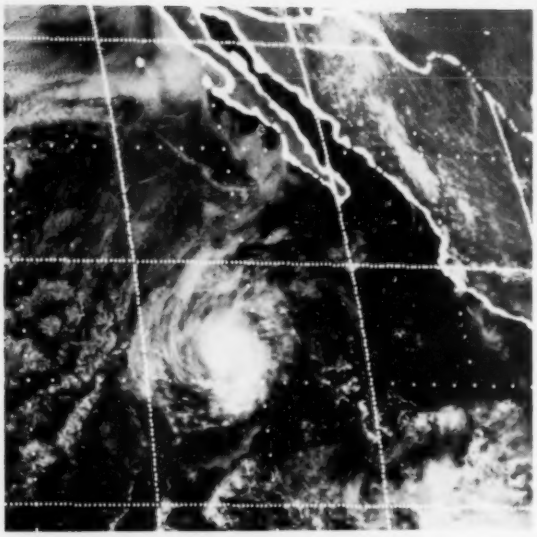

Figure 63.--Claudia was a small hurricane when this noontime image was taken.

Tropical Cyclones, Eastern Pacific--Claudia became the season's first hurricane on the 4th (fig. 63). She was first detected on the 3d about midway between Clipperton and the Socorro Islands and she intensified quickly. Cruising west-northwestward her maximum winds climbed to 80 kn for a brief time, but on the 5th Claudia fell to tropical storm strength. She continued on the same course at about the same intensity until the 6th. By the 7th she began dissipating and finally dropped off the weather charts near 16°N, 130°W.

Tropical Cyclones, Western Pacific--Sarah developed east of Leyte on the 16th. She moved north-northwestward and intensified despite passing through the Philippines. On the 18th Sarah turned westward and traveled across Luzon, north of Manila. By this time she was generating winds of 40 kn. Sarah reached typhoon strength on the 20th as 75-kn winds roared around her center, which was located just 120 mi southeast of Hainan. She headed northwestward and crossed that island later in the day. However, the land took its toll, and Sarah dropped to tropical storm intensity before crashing ashore over north Vietnam on the 21st. In the Philippines Sarah was responsible for 10 deaths, including 8 people who drowned when a boat sank.

While Sarah was skimming across the Gulf of Tonkin (fig. 64), Thelma was coming to life in the Philippine Sea near 15°N, 130°E. Moving west-northwestward, Thelma reached typhoon strength on the 23d shortly before clipping northeastern Luzon. Winds were up to 80 kn near her center. The KAKUHO MARU reported roaring 80-kn winds and 20-ft waves northwest of the center. Thelma turned northward on the 24th (fig. 65). Winds increased to 85 kn with gusts to 105 kn as the typhoon approached southern Taiwan. The PRESIDENT MCKINLEY was about 70 mi northeast of the eye at 1800 with 45-kn winds and 20-ft seas and swells. The ERIKA BOLTEN (21°N, 122°E) was

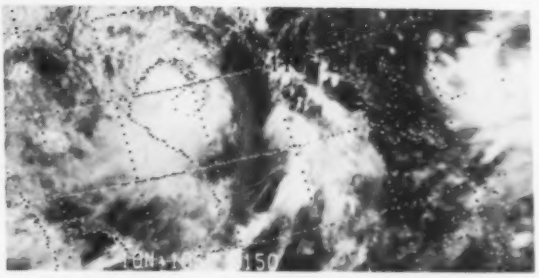

Figure 64.--Sarah sprawls across the Gulf of Tonkin, while Thelma is just visible east of the Philippines.

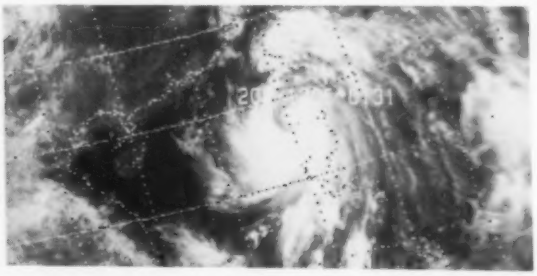

Figure 65.--Thelma as viewed over the Luzon Strait on the 24th.

northeast of the eye and reported 37-kn winds and 16-ft waves. Thelma brought her strong winds and torrential rains to the west coast of Taiwan on the 25th. The rains continued for several days as she made her way across the Formosa Strait and into mainland China. Four rivers swelled by the downpours flooded southern Taiwan, inundating buildings and farmlands and driving more than 10,000 people to their rooftops (fig. 66). At least four people drowned in the worst flood in more than three decades.

The port of Kaohiung was devastated. All eight of its container-handling cranes were demolished. The Harbor Bureau had to forbid any container ships without onboard cranes from entering the harbor. In addition to the cranes, 32 vessels were sunk (fig. 67). The U.S. tanker GAINES MILL capsized and grounded near the port. The vessel was in tow from California

Figure 66.--This automobile was a victim of strong winds and flood waters. United Press International Photo.

Figure 67.--The 3,000-ton oil tanker CHENG LUNG lies on her side in a calm Kaohiung Harbor after the storm. United Press International Photo.

to Taiwan for breakup. Also, the FRESNO CITY was reported to have sustained serious damage in the harbor. The PRESIDENT LINCOLN found 50-kn winds and 20-ft waves over the southern Formosa Strait at 0000 on the 26th, after Thelma had penetrated mainland China.

Typhoon Vera formed north of the normal area of development. She was spotted about 150 mi southeast of Okinawa on the 28th. Vera moved west-southwestward and intensified to typhoon strength by the 29th (fig. 68). At 0000 the ZUIHO MARU fought 45-kn easterly winds and 15-ft waves 60 mi northeast of the eye. After dipping slightly southward the typhoon turned to the west-northwest and took aim on northern Taiwan. At 0000 on the 30th the PORT LATTA MARU was within 40 mi of the center with 45-kn winds, 25-ft waves, thunderstorms, and a pressure of 990 mb. By the 31st winds near her center were blowing at 110 kn with gusts to 135 kn. Vera brought her destructive act to the northern part of the island later that same day. Winds blew down houses, while rains caused numerous mudslides. The death toll stands at 38, including 5 people who were crushed when winds collapsed a steel bridge support in downtown Taipei. The support, which was designed to hold up a footbridge being built over a street, fell and smashed five vehicles including two buses. At the port of Keelung three of the four dockside container-handling cranes were damaged or destroyed. However, timely warnings and the occurrence of Thelma a week before prompted most ships to put to sea to ride out the storm.

Three Japanese islands in the Ryukyu group east of Taiwan were hard hit. Almost all power and telephone lines were knocked down by recorded 135-kn winds; the barometer reading was 925 mb. The typhoon destroyed 131 homes and damaged 1,063 others. Two ships sank, 10 went aground, 3 were washed away, and 22 were damaged. Three people died and three others were missing from the sunken ships. Crops were also heavily damaged.

On the last day of the month tropical storm Wanda flared up just south of Iwo Jima. She moved northward and reached a 45-kn peak on August 1 about 60 mi west of Chichi Jima. That same day Wanda fell to depression strength. She turned toward the northeast, briefly regained tropical storm intensity on the 3d, but then dissipated the following day.

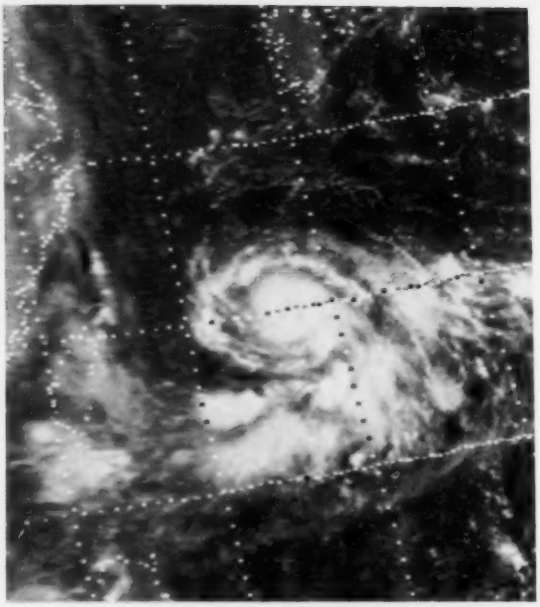

Figure 68.--It was early morning local time on the 29th when Vera was caught as she approached Taipei.

Casualties--Dense fog caused seven ship collisions in Japanese waters on the 2d. The 2,988-ton KURENAI MARU and the 508-ton IL SHIN HO collided in 500-m visibility while both were sounding alarm whistles. The 986-ton RAKUSHO MARU and the 199-ton ICHIYO MARU, both tankers, collided near Yashima Island. Near the same island, the 999-ton WA PYONG CHUNG MUG and the 179-ton FUEI MARU collided. After daylight the Liberian-registered freighters HUGH EVERETT (5,822 tons) and the THOMAS EVERETT collided off Kobe lighthouse. In the Tokai region the 1,512-ton NIPPO MARU NO. 76 and 491-ton SANEI MARU No. 1 collided. Later in the morning the 424-ton TOKO MARU No. 8 hit the SANEI MARU No. 1. There was no serious damage to the three vessels. At the mouth of Tokyo Bay the 8,900-ton Greek freighter ASSOMATOS collided with the 498-ton EIFUKU MARU No. 7.

The 16,518-ton American PRESIDENT TRUMAN was struck by the American EXPORT BUILDER (7,939 tons) in Pusan Outer Roads in dense fog on the 4th. On the 5th the 499-ton DAIYU MARU No. 8 and the 499-ton WASASHU MARU No. 18 collided in heavy fog. The DAIYU MARU sank with two crewmen missing. The 24,027-ton TRINITY MARINER was surveyed at Keelung for heavy weather damage on July 5 and 8. The Japanese car ferry KAWANOE (2,886 tons) and the South Korean container ship VENUS (1,998 tons) collided on the fog-shrouded Inland Sea early on the 12th. The AUSTRAL ENDURANCE encountered heavy weather on the 24th and lost 27 containers overboard on a voyage from New York to Sydney.

Marine Weather Diary

NORTH ATLANTIC, OCTOBER

WEATHER. Storms in the middle and higher latitudes increase in frequency and energy during October. The westerlies have pushed southward, and the 1002-mb Icelandic Low, centered about midway between Iceland and southern Greenland, is deeper and larger than it was in September. The Azores High, centered near 34°N, 35°W, is only slightly weaker (at 1020 mb) than in the preceding month, but it has diminished in size.

WINDS. North of 40°N, the prevailing winds are westerly and generally of force 4 to 6 north of 50°N, and force 3 to 5 between 40° and 50°N. The exceptions are: southerly over the Norwegian Sea, southwesterly over the North Sea, Baltic Sea, and adjacent waters, variable near the Icelandic Low, and light (force-2) northwesterlies through north- to southeasterlies around the Davis Strait. South of 40°N, northeasterly winds prevail of force 3 to 4. Southeasterly force-3 winds blow near the Equator between South America and Africa. Northwesterly winds of force 2 to 3 are prevalent over the Mediterranean Sea.

GALES. Both the frequency of and the area subject to gales increase markedly over the previous few months. Winds of force 8 or more can be expected oceanwide north of about 40°N, with a frequency from 5 to over 20 percent. The highest frequencies occur over a small area south of Greenland's southern tip, the Greenland Sea, and the northern portion of the Norwegian Sea. An analysis of eight Ocean Station Vessels north of 40°N indicates that gales generally last less than 1 day over these waters.

EXTRATROPICAL CYCLONES. The temperature contrast off the Atlantic coast, from Labrador through the Carolinas, is conducive to cyclogenesis. Other principal areas of cyclogenesis lie over midocean within an egg-shaped area oriented in a northeast-southwest fashion and comprising a 250- to 300-mi-wide area between 56°N, 23°W, and 48°N, 37°W; over the Bay of Biscay; within the coastal area from Marseilles east-southeastward to Naples; over all but the extreme southern part of the Adriatic Sea; over the Skagerrak, the Kattegat, and the Baltic Sea to about 61°N; off the northern Norwegian coast; east of Iceland; and off the Denmark Strait coast of Greenland. There are more extratropical cyclones than in September, but primary storm tracks are similar, although most are displaced a little farther south. The secondary cyclone track over the northwestern Mediterranean area has lengthened and become of primary importance. Primary tracks are also found over North America from Kansas across the Great Lakes to James Bay, and from James Bay to the Labrador coast. From the Newfoundland-Labrador coasts, the main track is toward Iceland. Another shorter track exists, about 5° latitude south of the main track in midocean. A single track extends from south of Iceland to northern Norway. Occasionally, North Atlantic extratropical storms, being of considerable intensity, generate hurricane- or near-hurricane-force winds.

TROPICAL CYCLONES. The hurricane season continues into October, but after the middle of the month, the probability of a tropical storm occurrence diminishes rapidly. An average of 3 to 4 tropical storms will occur each 2 yr, and about half will develop to hurricane strength. The vast majority of the storms develop before the 21st of the month. Most October storms form over the western Caribbean, but some are spawned near the Lesser Antilles.

SEA HEIGHTS. During October, sea heights of 12 ft or more are usually encountered 10 percent or more of the time over the open ocean north of about 40°N (excluding most of the Norwegian Sea), over the Gulf of Lions, and over central Hudson Bay. An area of 20-percent frequency extends southward out of the Denmark Strait, then eastward south of Iceland to the Faeroe Islands, and westward around Kap Farvel into the Labrador Sea. The southernmost point of the southern boundary is about 57°N, near 35°W. A second small area, about 4° in diameter, is centered near 50°N, 40°W. The areas described above very closely approximate the 10-percent frequency for waves of 20 ft or greater.

VISIBILITY continues to improve during October, compared with the previous month. Frequencies of 10 percent or more of visibility less than 2 mi are now found in only three scattered areas--the southern Davis Strait and northern Labrador Sea, over waters due east of Newfoundland, and from the southern reaches of the Denmark Strait southeastward to the Faeroe Islands and then north-northeastward to the Greenland Sea. As in September, the cold waters north of Iceland entertain an area of 20- to 30-percent frequency of visibility less than 2 mi, and a small area (within this larger area and centered near 68°N, 18°W) where visibility less than 2 mi exceeds 30 percent of all observations.

NORTH PACIFIC, OCTOBER

WEATHER. October marks the transition to winter conditions over the northern latitudes of the North Pacific. The Aleutian Low, lying off Cape Newenham, Alaska, has deepened 4.5 mb (as compared to September) to 1002.5 mb, while the subtropical High has become a flat east-west ridge, centered roughly along the 33d parallel, containing a maximum pressure of about 1020 mb.

WINDS. Between 40° and 60°N, westerly winds predominate, with forces 4 to 6 most frequent. However, northwesterlies and northerlies prevail over the eastern Bering Sea, easterlies dominate the Gulf of Alaska, and winds off the coast of British Columbia normally blow from the southwesterly quarter. North of 60°N, the winds are northerly to northeasterly at force 3 to 5. From 30° to 40°N, directions are more variable, with northeasterly and northerly winds prevalent east of Honshu, and northwesterlies common east of the dateline, shifting to northerly near the California coast. Force-4 winds constitute the largest percent-

age frequency within the above latitudinal belt. The northeast trades, which average slightly less than force 4, prevail between the Equator and 30°N. Northerly force-3 winds are the general rule out from the Gulf of Tehuantepec. The winter monsoon is now well established over Asiatic waters, penetrating as far south as Indochina.

GALES. The chances of encountering winds of force 8 or higher increase appreciably in October, particularly in the middle and higher latitudes. The highest incidence of gales occurs between 48° and 56°N, from Kamchatka eastward to about 140°W, with over 10 percent of the wind observations over most of these waters revealing gales. Ships plying the central Bering Sea as far north as the 63d parallel are also laced by gale-force winds more than 10 percent of the time. There is a gradual decrease in frequency southward--gales are infrequent south of 30°N over the central ocean, 35°N over the western ocean, and about 44°N above eastern waters. Nevertheless, gales are observed between 5 and 10 percent of the time over the typhoon-troubled waters near Taiwan, and those southwest of Japan.

EXTRATROPICAL CYCLONES. The frequency and intensity of extratropical cyclones increase in October. The principal sources of storms, or cyclogenesis, are the Mongolia - Manchuria area and the seas south of Japan. Other areas are along the Aleutian Islands, and over the midocean slightly north of latitude 40°N. The primary storm tracks extend from across Sakhalin and south of Japan toward the Near Islands. From there, the track parallels the Aleutian Islands into the Gulf of Alaska. Another track comes out of the midocean source area into the Gulf of Alaska. A secondary track departs the Near Islands for the Bering Strait.

TROPICAL CYCLONES. Three or four tropical cyclones can be expected to develop over the tropical waters of the Far East. On the average, two or three reach typhoon intensity. Most of these tropical cyclones form at low latitudes in an area extending from the Philippine Islands to about 155°E. Their early movement is generally west-northwestward, and most recurve east of the Philippines or Taiwan and sweep up along the east coast of Japan. A smaller number move across the Philippines into the South China Sea; a still smaller number reach the Asiatic mainland.

In the tropical waters of the eastern North Pacific, tropical cyclones are less frequent than in September, averaging about two per year. Roughly half of these storms reach hurricane intensity at some time in their lives. October tropical cyclones follow less regular tracks than those of September. After developing off the coast of southern Mexico-Guatemala, or near the Revillagigedo Islands, a large percentage of these storms will move inland over Mexico, south of about 30°N.

SEA HEIGHTS. The frequency and area of high waves increase, especially over the northern shipping lanes. The area bounded by approximately 43°N, 160°E, 145°W, and the Aleutian Islands, has 12-ft or higher waves over 10 percent of the time. In general, the area from coast to coast between 30° and 55°N will have seas 12 ft or greater, 2 to 10 percent of the time.

VISIBILITY. Percentage frequencies of low visibility decrease in October. Visibility less than 2 mi occurs 10 percent or more of the time north of a line drawn from Ostrov Karaginski eastward to a point northeast of the Pribilofs, and then southwestward across the Fox Islands to a point near 42°N, 175°W. From there, the line extends eastward across the 155th meridian, and then northward to Kodiak Island.

NORTH ATLANTIC, NOVEMBER

WEATHER. While normally November is considered a transitional period between fall and winter weather over northern waters, this month occasionally develops some of the severest weather of the winter season. Most rough weather is confined to north of 45°N, except along the coast of the United States, where there is an increase in winter-type LOWs. Over the Great Lakes Region, two primary storm tracks--of Alberta and Colorado LOWs--converge into an area of maximum cyclone frequency, contributing in a large measure to rough weather toward the close of the Lakes' navigation season. The Icelandic Low (1002 mb) is still centered between Iceland and southern Greenland. The Azores High has shifted eastward and is centered near 33°N, 29°W; its central pressure has risen slightly to about 1021 mb.

WINDS north of 60°N are quite variable at about force 4 to 5, although these winds tend to come from the northerly quarter west of Iceland, and from the southerly quarter east of that island nation. Westerly winds, force 4 to 6, prevail over most of the ocean between 40° and 60°N. Between the latitudes of 30° and 40°N, force 3 to 4 winds are of variable direction, except east of the Azores, where a noticeable northerly component prevails. The northeast trades, averaging force 3 to 4, extend from 30°N southward to 10°N. Between 10°N and the Equator, southeasterlies (force 3) are predominant.

GALES. The frequency of gales over northern and middle latitudes increases substantially in November. Winds of force 8 or higher occur 10 percent or more of the time over most areas north of about 35°N over western waters; north of about 40°N over the central ocean; and north of about 44°N over eastern waters, including the southern half of the North Sea. A 10-percent frequency of gales is encountered on the Mediterranean only over the Gulf of Lions. Frequencies are generally less than 10 percent, however, over the waters between Iceland and southern Greenland (near the center of the Icelandic Low), over a relatively small area about 200 mi northwest of the western Irish coast, and over and south of the Irish Sea. Frequencies of 20 percent or more occur in the Davis Strait north of 63°N, south of Greenland in the vicinity of 55°N, 45°W, and over most of the Greenland and Norwegian Seas.

EXTRATROPICAL CYCLONES. The principal track of extratropical LOWs is northeastward from the waters off Cape Cod, across Newfoundland to Iceland, and then through the Norwegian Sea. Sometimes these

cyclones will approach Iceland from the central part of the North Atlantic Ocean. Other major tracks lead from Hudson Bay to the Davis Strait, and from the Gulf of Lions to Italy.

TROPICAL CYCLONES are infrequent in November. Usually, one storm in 3 yr may be expected, and about half will develop to hurricane intensity. Most of these storms develop over the Caribbean Sea or eastern Gulf of Mexico, and are soon following a northeasterly path out over the main body of the North Atlantic.

SEA HEIGHTS of 12 ft or more are encountered more than 10 percent of the time on most of the ocean north of about 40°N and south of the Davis Strait and the Norwegian Sea, and on the Mediterranean Sea in the Gulf of Lions and the northern Aegean Sea. The frequency increases to 20 percent or more over most of the waters between 47° and 60°N, and extending into the Denmark Strait.

VISIBILITY less than 2 mi reaches a frequency of 10 percent north of a line drawn from the waters around, and 200 mi south of, Kap Farvel west-northwestward to Saglik, Labrador (55 mi northwest of Cod Island); and north of another line extending from Angmagssalik, Greenland, to northwestern Iceland, then across land to the Vesturhorn (eastern Iceland), then eastward to 64°N, 07°W; it then stretches north-northeastward across the Norwegian Sea to the waters north of Norway. An area of frequencies exceeding 20 percent or more lies north of Iceland between 67° and 72°N, and westward from 05°W to Greenland.

NORTH PACIFIC, NOVEMBER

WEATHER. November is often a stormy month north of 35°N over western waters, and about 40°N over the eastern ocean. There have been years when November was the stormiest month of the winter season, but generally the weather is not too severe, and there may be quiet periods lasting several days. South of 40°N, the probability of severe extratropical storms diminishes rapidly with latitude. During November, the Aleutian Low, near 57°N, 170°W, is well established over northern latitudes, with a central pressure of 1000 mb. The Pacific subtropical High, at 1021 mb, is slightly stronger than in October and is centered near 33°N, 140°W. Off the Chinese coast, pressures are higher than during October because of the buildup of the cold Asiatic High.

WINDS. Over the ocean north of 55°N, northerly winds (force 4 to 6) prevail, except over the eastern Bering Sea, where winds are variable, and the Gulf of Alaska, where easterlies and northeasterlies are most common. With the exception of the area east of 140°W, where southerly and westerly winds are prevalent, westerly winds (force 4 to 6) predominate between 55° and 35°N. Variable winds near force 4 are most frequent between 35° and 25°N, except over the Yellow Sea and waters off Japan, where northerlies predominate. The northeast monsoon (affecting areas west of 140°E) and the northeast trades blow steadily at about force 4, south of 25°N. Lighter force 2 to 3 winds are the rule over the southern limits of the South China Sea, east of the Gulf of Siam. Northerly winds blow steadily out from the Gulf of Tehuantepec, off Mexico's south coast. They reach gale force between 5 and 10 percent of the time just west of the gulf.

GALES occur 5 percent or more of the time north of about 35°N. An area of 5- to 10-percent frequency is also found over the northern reaches of the South China Sea, including the Formosa Strait and the Luzon Strait, and west of the Gulf fo Tehuantepec, as mentioned above. Actually, a frequency of 10 percent or more is found over most of the waters north of 39°N, with the exception of the eastern Pacific east of 154°W (south of 50°N) and the waters east of the Kamchatka Peninsula. A small area of maximum frequency, where gales occur 20 percent or more of the time, is centered about 225 mi southeast of the southern tip of Kamchatka.

EXTRATROPICAL CYCLONES. The main storm tracks extend northeastward from the Japanese Islands to the western Aleutians, and then east-northeastward to the Gulf of Alaska. Another primary cyclone track enters the gulf from an area in the central ocean near 47°N, 169°W. In November, there are more LOWs passing over the Gulf of Alaska than any other part of the Northern Hemisphere; this is also true of 5 of the following 6 mo.

TROPICAL CYCLONES. On the average, two or three tropical cyclones develop over the western North Pacific in November. Two of these usually reach typhoon intensity. The region of most frequent formation is in the vicinity of the central and western Caroline Islands; the tropical cyclones either travel west-northwestward over the Philippines and the South China Sea, or recurve near 15°N, 132°E, to pass east of the Japanese Islands.

Tropical storm frequency over the eastern North Pacific drops rapidly for November, averaging about one every 3 yr. None have developed to hurricane intensity. Tropical storms very seldom occur in the central North Pacific--maybe one every 20 yr. When these late-season storms do develop in the eastern ocean, their direction of movement is usually more northerly than westerly.

SEA HEIGHTS. The area with 12-ft or greater seas and a frequency of 10 percent is bounded by the Aleutian Islands, 158°E, 43°N to 160°W, where the latitude drops to 35°N, and a line from 35°N, 150°W, to the Queen Charlotte Islands. A small area between Hong Kong and Taiwan is also affected, as is a large part of the Sea of Okhotsk. High-swell observations are found north of 30°N, with a tongue extending to the Equator east of the Hawaiian Islands. These observations are more frequent off the State of Washington coast, south of Kodiak Island, and east of the Kuril Islands.

VISIBILITY. Frequencies of low visibility (less than 2 mi) greater than 10 percent lie north of a line drawn from Mys Terpeniya, Sakhalin, eastward across the central Kurils, and then north-northeastward to the waters east of the Komandorskiye Islands. From there, the line stretches northeastward to St. Lawrence Island and the Seward Peninsula. Two smaller regions of 10-percent or greater frequency are centered over the Bering Sea, near 54°N, 173°W, and over the midlatitudes of the eastern North Pacific, near 46°N, 146°W.

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